

SPACE, DESIGN, AND THE DESCRIPTION  
OF THE BUILT ENVIRONMENT

A Theoretical Enquiry into Some  
Structural Aspects

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Ph.D. Thesis

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1979.



DECLARATION:

I declare that this thesis is my own original work.

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## ABSTRACT

This thesis is concerned with theoretical aspects which underlie the establishment of a methodological framework which i) takes into account the problem characteristics of the field of built environment; ii) investigates the implications of these problem characteristics on the type of architectural knowledge which can be produced and also on the limits of the methods employed for obtaining it; iii) evaluates the operational value of this knowledge at the level of design practice.

There are three major proposals made for the methodological framework. The first emphasizes its structural character. The second identifies problems of organization and production of artificial space as furnishing the specific domain of its empirical orientation. The third argues the necessity for this framework to maintain an operational link with architectural practice at the level of the architectural prototype. /

The particular epistemological paradigm invoked in order to evolve the framework is the structuralist approach, which consists of many strategies. The structuralist strategy which has been systematically operationalized within the context of the thesis is (borrowing the term from linguistics) the syntagmatic one, where special emphasis is placed on the priority of the synthetic level of consideration in the investigation of architectural realities.

The potential and limitations of the structural syntagmatic

framework to deal comprehensively with the complexity and dynamics of architectural structures has been explored, as has the contribution it makes to the elucidation of the concept of the architectural prototype. The study of prototypes is proposed as a productive research paradigm which furnishes the key-link between (and provides for the conceptual unity of) architectural theory and architectural practice.

Two interconnected areas of research on prototypes are suggested. The first relates to the investigation<sup>o</sup> of the prototypic potential of the built environment, while the second relates to the development of design-specific prototypes. The thesis offers an illustrative example of the second area of research, which is evolved within the constraints of a new group of polyhedra independently identified and characterized by the author. The architectural extensions of this example and its potential for further development are explored.

## ACKNOWLEDGEMENTS

This thesis was written under the supervision of Professor C.B. Wilson, Professor of Architectural Science in the Department of Architecture. He has been generous of suggestions, criticism and time. My sincere gratitude is due to him for his constant guidance and friendly encouragement.

My sincere gratitude is due also to my friends and colleagues Drs T. Kotsiopoulos and T. Maravelias. I am particularly indebted to them for the extended sessions of stimulating discussion and for their most productive collaboration. The two papers describing the collective research work we carried out are included as Appendices I and II.

I am also indebted to Dr E.A. Lord, Post Doctoral Research Fellow in the Department of Architecture for reading an earlier version and the final manuscript of Chapter 10. I have found his suggestions and critical comments of considerable help.

During my stay in the United Kingdom, I have received financial support from the University of Khartoum for which I am thankful.

Miss J. Clarke typed the final draft. I thank her for her grace and expert typing.

I have received moral and intellectual support from many friends and colleagues. They will forgive me for not being able to name them individually here, but their support is sincerely appreciated.

Finally, I am most grateful to all the members of my family who have accepted with patience and great understanding my years of absence and devotion to this work at a time of exceptionally difficult circumstances. On their behalf, I dedicate the results of this work to the memory of my father, Awadalla Mohy El Dean.

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## GENERAL INTRODUCTION

The search for new methodological frameworks is, of course, not new. It is customary to advocate such a search whenever a discipline reaches a certain level of maturity or alternatively (to paraphrase Kuhn, 1970) whenever it is in a state of crisis. In the case of the present crisis which architecture is commonly acknowledged to be in, it is the difficiency of its theories which is accepted as the cause for concern, rather than their over-maturation. One particular manifestation of this difficiency has long been identified in the shape of the so-called 'applicability gap'. This has prompted and continues to prompt calls for a new methodological framework under which research would be differently organized in order that its results could be more effectively linked to design practice.

Unfortunately, the majority of these calls have been limited to criticism of past methodological efforts. There are, however, a number of positive contributions of design-theoretic interest available in the literature, though their comprehensiveness varies. Some of these have been made use of in elucidating aspects of the kind of methodological framework proposed in this thesis.

The particular contribution from which this thesis has gained most is the collaborative work carried out by the author and his colleagues, Drs T. Kotsiopoulos and T. Maravelias. The two papers describing this work are included as Appendices I and II. The specific points within the main text which relate directly to these

two appendices have been duly acknowledged. Of considerable help also have been the active interest, and numerous critical comments of my supervisor Professor C.B. Wilson. However, the specific view presented in the thesis and the arguments associated with it remain those of the author.

There are usually two major reciprocal aspects to any methodological framework. One is conceptual, the other is empirical. The first provides the abstract tools and establishes the theoretical basis on which any such framework is articulated and apprehended. The second identifies the domain of its operation which gives it its particular character and constitutes the basic reference by which it realizes both its potential and its limitations.

In terms of architecture, the first aspect relates to architecture as a particular conceptual mode for the study of the built environment and its object-systems and structures. By necessity, such a level is predominantly descriptive where description is taken to include explanation. The second (that is the empirical) relates to architecture as a practice for producing the built environment. This is fundamentally design-specific in character. Now, since architecture operates both as a conceptual mode and as a practice, the ultimate effectiveness for any of its theories is governed by issues of practice. This is an operational requirement and it emphasizes that architectural theories are predominantly theories about practice or should at least evolve in close relationship to the practice they hope to influence. It is by keeping a strong link with issues of practice that the usefulness of these theories

can be properly evaluated. It is, therefore, strategically important to clarify the nature of this link in order to safeguard the practical importance of theoretical investigation.

The discussions contained in this thesis are concerned for the most part with the conditions under which this link can be maintained and further strengthened. The thesis does not, however, belong to the debate on design methods or techniques proper, but more importantly to the field in which the basic assumptions of developing or using any such method or technique can be justified.

There is no intention to present a completely formalized methodological framework. This is undoubtedly a task beyond any individual effort within the time-scale of a PhD thesis. The aim is to propose a working perspective which can be made increasingly rigorous, and whose underlying premises, potentials and limitations are fully exposed. Within the confines of the thesis, several important aspects of this perspective have been identified and related to similar efforts.

There are three major proposals made for this perspective. The first is that it should be 'structural'. Secondly, that it should take 'space' as its first objective basis, since this gives its specific architectural character and limited empirical orientation. Thirdly, that it should seek an operational link with practice at the level of 'the architectural prototype'.

The high level of logical complexity and multidisciplinary integration involved in all types of built environment object-systems means that they should be viewed as architectural totalities

before deciding which of their many particular aspects deserve further attention and before choosing the conceptual tools appropriate for their investigation. In the view presented in this thesis, this is a structural requirement. The framework envisaged is, therefore, structural, and the particular paradigm invoked in order to evolve this framework is the 'structuralist approach'. However, the extension of structuralist thinking to architecture has been contextually defined, first, by insisting that it should be (borrowing the term from linguistics) 'syntagmatic', and, second, by operationalizing the syntagmatic framework within the context of architecture.

The syntagmatic framework accepts the necessity of syntax as an organizing principle in any coherent system, but also insists on the simultaneous involvement of the 'semantic dimension' in its adequate investigation. The proper strategy, therefore, is not to argue the primacy of one dimension over the other, but to investigate (within the context of the system under consideration) the dialectical involvement of each in generating the necessary conditions for the other without being reduced to it. The level at which this operates is the syntagmatic level. Though still abstract (that is it does not belong to the surface level), the most important characteristic of the syntagmatic level is that it is a highly synthetic one. And while it allows for a variety of syntaxes, it is usually dominated by systems of social evaluation which are historically originated. This is typical of the nature of architectural structures. Methodologically, therefore, the system of social evaluation which is historically dominant at the

time plays an internal structural role not only in terms of the production of particular architectural realities, but also in terms of the methodological tools employed in their study.

While architectural theories are of necessity multidisciplinary, there are aspects of them which make them specifically architectural. These, in the main, revolve around the idea of the coherent artificial organization of space for the purpose of human habitation and activity, and the meaning of that space and its enclosing forms for its users and for society as a whole (Oakley, 1970, p.162). Hence the view taken in this thesis is that architectural space should provide the empirical domain against which the validity of methodological frameworks is to be evaluated: whatever helps the understanding and production of this space helps the understanding and production of architecture. As a reality, architectural space embodies a natural component (environmental fields) a tectonic component (the architectural body or building) and a human component (the producing/consuming subject). In its totality, it exists only through the interaction of these components *between* and *within* themselves.

At the design specific level, however, concern with architectural space must be closely related to its production; mainly, but not exclusively, through the preconceptions of those who design it. In general, these preconceptions are based on complex processes which reflect the internalization of equally complex spatial prototypes or schemata in the structure of which environmental, socio-economic, cultural, and other aspects of the built-environment have been well integrated. The influence of

these already structured prototypes on any new act of design is initially decisive and it may continue to be so throughout the design process and beyond (at the level of consumption). The methodology proposed in this thesis suggests a structural syntagmatic approach based on the notion of prototype. It is the study of prototypes which is seen to present the most appropriate operational link between (and provide for the conceptual unity of) architectural theory and design practice.

The main text of the thesis is divided into four parts. Part I includes Chapters 1, 2, 3 and 4, gives the general orientation of the thesis and establishes the need for the development of an integrated methodological framework.

Chapter 1 is a critical examination of the theoretical formulations whose premises originated outside architecture. It argues the case for domain-specific theories of architecture and the necessity of involving issues of design practice at the very bases of their formulation. A feasible strategy is for theory to operate at the level of the architectural prototype.

Chapter 2 traces the historical emergence of space-consciousness in architecture. It provides evidence for the epistemic and methodological importance of developing an appropriate conception of space in both architectural theory and practice.

Chapter 3 carries out a critical review of some major approaches to space which are active now in the field of environmental studies.

It identifies a variety of positive concepts and terminological tools which these approaches have produced.

Chapter 4 attempts a general elucidation of the concept of architectural space. This eventually focuses the attention on the logical complexity involved in dealing with built environmental realities as totalities. As a methodological consequence, the need for a structural approach becomes more urgent.

Part II consists of Chapters 5, 6 and 7 and contributes to the formulation of the structural framework.

Chapter 5 discusses the contribution which the structuralist paradigm makes to the development of this framework. The extent to which this contribution is accepted is guided by its architectural relevance and limited to its ability to involve the specific characteristics of architectural object-systems.

Chapter 6 is concerned with equipping the structural framework with syntagmatic interpretation paying special attention to problems of meaning and evaluation. The degree to which the concepts of the linguistic syntagm and the architectural prototype are comparable is systematically analysed, and an operational definition of the latter in terms of the former is conducted.

Chapter 7 develops the syntagmatic structural framework further by involving issues of description and descriptive theories in architecture. The close connection between theory and practice in architecture is once again re-emphasized.

Part III is subdivided into Chapters 8 and 9. It elaborates the discussion on the notion of the architectural prototype and explores its potential at two levels; i) as a design tool; and ii) as a research tool.

Chapter 8 investigates the idea of prototype in conjunction with a series of similar notions advanced in the literature. The conceptual influence these notions have on reorientating design theory is discussed and the way this reorientation supports the approach developed in the thesis is evaluated.

Chapter 9 suggests two areas of research on architectural prototypes. The first is concerned with investigating the prototypic potential of the built environment and is termed 'prototypic analysis'. The second is the development of 'design-specific prototypes', where new prototypes are to be proposed and analysed, and their problem-solving capacity in response to certain problem-fields is to be assessed.

Part IV consists of Chapter 10. It offers a preliminary example which illustrates the possibility of developing design-specific prototypes within the constraints of particular spatial forms. The example presented is based on a new group of polyhedra independently identified and characterized by the author.

Part IV is followed by a set of general conclusions which summarize the major arguments in the thesis and re-emphasize the importance of research on architectural prototypes.



There are three Appendices. Appendices I and II (which are a reproduction of two papers written collectively by the author and his colleagues Drs. T. Kotsiopoulos and T. Maravelias) supplement the whole thesis, particularly Part II. Appendix III is exclusively graphical and is especially designed to supplement Chapter 10.

## PART I

### CHAPTER I

ARCHITECTURAL THEORY, DESIGN METHODS AND SPATIAL DESIGN:  
A GENERAL CRITIQUE

### CHAPTER II

ARCHITECTURE AND THE HISTORICAL DEVELOPMENT OF SPACE-  
CONSCIOUSNESS

### CHAPTER III

ENVIRONMENTAL THEORIES OF SPACE: A CRITICAL REVIEW OF  
SOME RECENT FORMULATIONS AND THEIR APPLICATIONS IN BUILT  
ENVIRONMENT STUDIES

### CHAPTER IV

SPACE, ARCHITECTURE AND STRUCTURE

## CHAPTER 1

### ARCHITECTURAL THEORY, DESIGN METHODS AND SPATIAL DESIGN: A GENERAL CRITIQUE

#### 1.1 INTRODUCTION

Current critical accounts of theoretical developments in architecture reflect a continued dissatisfaction with these developments and their manifest inability either to maintain a demonstrable influence over the course of particular approaches to design or to make a sustained contribution to the resolution of outstanding methodological issues facing everyday architectural practice. This inadequacy can be attributed to many sources, but traceable to two basic ones. The first is the increasingly weakening architectural basis of theoretical formulations, and the second is the pervasive reluctance on the part of theorists to take sufficient account of specific problem characteristics of architectural practice in the first place. Relevant to this is the fact that the scientific frameworks which inform these theoretical formulations, the vocabularies they employ, the main issues they discuss and the evaluative measures and criteria of usefulness they apply remain *aprioristic* and faithful to the parent disciplines from which they originate rather than reflecting a genuine concern for their architectural specificity or design practicability.

Now, it is suggested here that the resulting state of dissociation and disinterest (generally ascribed to <sup>a</sup>so-called 'applicability gap') on behalf of practitioners towards both the theories advanced and the research results produced justifies the proposition that new theoretical efforts should reflect a dual concern. On the one hand, they should maintain a high level of a domain-specific architectural identity which may, therefore, have a direct bearing on the limits of what they can achieve. On the other, they should attempt to address questions of architectural practice at the very bases of their formulation. Imperative to such a 'theoretical-practice' is a conscious reorientation in emphasis from theories whose bases are external to architecture and stubbornly remain so, to theories whose nature is indigenously architectural or principally organized in close connection to architectural empirical reality and problems.

To advocate such a reorientation, however, is neither to deny the importance of the contribution of other disciplines nor to imply an isolation of architecture (the multidisciplinaryness of the phenomena its theory attempts to describe and the products its practice envisages and produces is undisputable). Rather it is a realization that, first, there can be no theory for investigating an aspect of the built environment which is totally divorced from a theory of the built environment itself. Secondly, architecture besides being a conceptual mode for studying the built environment, is also a practice for producing it. Therefore, it has to accept the duty of accounting for its design actions. This means that as products of architectural activity, built environment phenomena should be explained within a recognizably coherent architectural perspective,

rather than simply dealt with in an *ad hoc* fashion by immediate reference to other disciplines.

The contribution of other sciences is, of course, of the utmost importance, but the analytic results obtained on their bases have limited explanatory power if they are not considered under broad architectural contexts. To this effect, architecture must unquestionably raise the problem of what is specific to it and what is not, and together with this develop coherent methodological frameworks within which disciplinary criteria of relevance can be imposed on what it borrows and claims to be pertinent to its problems. Otherwise, and although the continued *ad hoc* search for analogies and metaphors may leave a residue of useful notions and ideas (as occasionally it does), such a search is most unlikely to succeed under the severe demands of such a highly product-orientated and practice-laden discipline like architecture.

This chapter seeks a clarification of this argument and extends the discussion to explore the limitations of uncritical use of external models and imported theories through a short critique of two types of modern formulation whose theoretical bases have been largely exogenous to architecture. This refers to the so-called systematic design methods and their closely linked counterparts, the analytic space/activity models.

## 1.2 THE CASE FOR INDIGENOUS THEORY AND THE DEMAND FOR SPECIFICITY

The general case for indigenous theories is not without precedent and can be supported at two levels of consideration. The first is essentially historical. It relates to the visible successes attributed to past indigenous theories of architecture - whether formalized or not - and can be referred back as far as architecture existed. The second is comparative and calls into evidence the recent successes made by indigenous or contextually redefined theories in some socially cognate disciplines which until very recently seemed sterile.

### 1.2.1 Indigenous Theory to Architecture: a historical perspective

In historical terms, architecture and architectural design are as old as civilization. Many ancient man-made objects in the environment (the pyramids, Stonehenge and so on), argues Bazjanac (1974, p.3), provide ample testimony of an extraordinary ability to design. Is it possible then, he asks, that no theories of architecture or architectural design have ever existed in all that time?<sup>1</sup>

"An examination of the writings about architecture from the past shows that Vitruvius (probably a contemporary of Caesar and Augustus), Alberti (1404-1472), Filarete (1400-1469), Serlio (1475-1554), Palladio (1508-1580), Colonna (1433-1527), Guarini (1624-1683), Ladoli (1690-1751), Laugier (1711-1769) and others were

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1. *Even in traditional and vernacular architecture there must have been some theories at work. The fact that these were unconscious or informal cannot be argued as a proof of their non-existence or lack of viability.*

theoreticians in the deepest sense of the word. They all had their theories of architecture and a significant part of the contemporary body of knowledge called architecture is based on their work ...

These and other theories of architecture were accepted as general and quite satisfactory theories in their time, and therefore it is not true that there are *no* theories of architecture. The problem is that the theories of the past were concerned with issues quite different from issues of architecture and architectural design which are important today."

(Bazjanac, 1974, pp.4-5, his emphasis).

In fact, compared to past theories, contemporary theories, though argued in more complicated languages and enriched with sophisticated techniques, appear far poorer in their practical consequences and seem conspicuously to be founded on fragmentation. Instead of presenting a unified all-embracing view of architecture, they usually tend to present themselves as 'independent models' or more frequently as 'techniques', strongly influenced by their external disciplinary origins, and can only be related to isolated aspects of architecture, a logical consequence of an attitude which makes little effort to predicate theory on practice. The gaps both between them and between the results they produce and real-life design practice are very large.

However, an acute awareness of the dangers this state of affairs presents to the objectives of research prevails. Wilson (1973b, p.7) has warned against these dangers:

"Instead of the release which research is often supposed to provide from the trials and errors of a craft-based process, we may see only the institutionalisation of it. Because this collectivises the trials and errors, the process is coarsened, knowledge is valued above understanding, the product becomes secondary to the activity

which produces it and the inertia of the process favours the emergence of new directions less as deliberate ventures than as desperate remedies."

Such dangers are perpetuated, as pointed out by Gregory (1978) who discusses the problem in the context of human geography, by the fact that the objectives of using, say, an imported technique usually tend to be established outside the phenomena to which it is applied and as such the epistemological formulations on which the technique itself is founded tend to be excluded from critical analysis; and what the researchers appear to be doing is to modify the phenomena to meet the requirements of the technique. In comparison, the high level of comprehensiveness and rich empirical content some past theories, such as the Vitruvian one, have achieved reflect a superior quality which seems to be unattainable in many of their modern counterparts.

#### 1.2.1.1 Vitruvius and the problem of theory and practice

Vitruvius' theoretical framework is rich and wide ranging both in its multidisciplinary references and in the number of architectural aspects to which it attends. It prescribes that the architect's knowledge should be so wide ranging that no aspect of culture should be foreign to him and gives ample reasons why this multidisciplinary knowledge is so important. Vitruvius himself makes this reasoning credible by revealing his own vast knowledge (by the standards of the time) in these areas throughout his treatise. Yet he never propagates the view that this knowledge should be imported into architecture uncritically. His



architectural affirmations and the practically suggestive language in which he expresses this knowledge justify all the subsequent and unparalleled success his theory has achieved. He continuously problematizes the concepts he borrows within a perspective which is recognizably architectural and a methodology which is predicated on practice. In his conception of theory and practice he never displays an irreconcilable split between the two. Significantly, he is quite adamant that the knowledge the architect needs to acquire

"is the child of *practice* and *theory* .... It follows, therefore, ... that architects who aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their pains, while those who relied upon theories and scholarship were obviously hunting the shadow, not the substance. But those who have a thorough knowledge of both ... have the sooner attained their object and carried authority with them .... It appears then that who professes himself an architect should be well versed in both directions."

(Vitruvius, 1960, Book I, Chapter 1, p.5, my emphasis)

This seems to embody an advanced outlook indeed, consonant with the modern Marxian concept of 'theory as practice'<sup>2</sup>. With hindsight, it implies that a good architectural theory can never be developed in the absence of the issues of the very practice it intends to influence and prescribe. Hence, its usefulness is essentially subject to empirical illustration<sup>3</sup>. It is in a

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2. *Extensive discussions on this can be followed in the works of L. Althusser and E. Habermas. See also Vazquez (1977) for a unified and critical text.*

3. *Such a view does not subscribe to 'empiricism as a philosophy', but to the central value of empirical evidence in any scientific enterprise.*

dynamic coexistence between the empirical basis of proving its correctness and the highly abstract basis into which this proof may be apprehended.

From the point of view of the present study, Vitruvius holds two conceptions which are indispensably valuable. One is the emphasis he places on knowledge in history. The other is his obvious concern with 'health' and 'comfort'. He justifies the first by remarking that one should be able to explain what one does through explaining its origin, the source of the knowledge and experience that made it possible. Thus, unlike many of the modern rationalized methodologies, he avoids locating the designer in a void. Past knowledge, tradition and experience are as important to the designer as the design task in hand. And in the most obvious way, the major source of all these is the built-environment itself.

On the other hand, his concern with health and comfort and other similar issues reflects a remarkable understanding that the objects designed (individual buildings, whole quarters or urban settings) should promote the welfare of those they are designed to serve, not only in terms of satisfying their immediate needs or sensations, but also in terms of the general and long-term conduct of their well-being<sup>4</sup>.

This is roughly equivalent to the view that through such a value-laden criterion the products of design acquire their social

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4. *It is interesting to observe that recent reorientations in climatic design research are evolving a similar view, where the concept of 'comfort' acquires its significance, not only*

import and the ultimate evaluation of their significance and success cannot but be social. This makes his theory fundamentally anthropocentric. He clearly holds the view that the reason for the existence of architecture is man, and it comes as no big surprise when - even in its most formally stated instances, particularly those that relate to space (though he does not use the word as such or show a conscious awareness of it) - his theory remains firmly man-related through the imposition of the proportions of the human body as a tool of spatial design and formalism.

#### 1.2.2 The Case for Specificity in Other Disciplines

Concern with developing indigenous theories in relation to particular domains of investigation has served the methodological purposes of a number of social disciplines remarkably well recently. Obvious examples relate to areas like those of modern linguistics and social anthropology. The present methodological success achieved in both areas can be attributed to two vital considerations. On the one hand, there have been original efforts on part of both modern linguists and social anthropologists to originate theories which are internally specific to the disciplinary phenomena they

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<sup>4</sup> (cont). *in terms of satisfying physiological requirements of the body but also includes psychological, economic, socio-cultural and so on evaluation, thus a basic function of building is to act as a 'climatic-modifier'. See Maravelias (1978), for an elaborate review and treatment of the new developments in building climatic design and the evolving conception of comfort.*

are dealing with. In terms of linguistics, for example, the originality and strength of the linguistic model has long been widely acknowledged<sup>5</sup>. On the other hand, there have been consistent attempts on part of both types of social scientist to ensure the relevance of imported theories by redefining them within the context of their respective disciplines. The development of the semiological model and its successful redefinition within the field of social anthropology provide a good example of such attempts. In view of this, it may suffice to present a summarized version of the epistemological reasons C. Lévi-Strauss has frequently emphasized in favour of the above type of methodological considerations.

In his succinct expository discussion of the Lévi-Straussian argument, Mepham (1973, pp.110-6) says that this argument relates to two requirements. The first is the demand for 'specificity'. The second is the demand for a 'theoretical critique of facts'. The demand for specificity constitutes a principle of methodological antireductionism. It says that in the first instance a science of a specific domain is based on the discovery of the specific coherence of its object. Before any question of any relationships between domains can be discussed meaningfully, one must have a theory of the specific difference which marks off one domain from

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5. N. Chomsky has repeatedly argued the case for having a theory which defines the characteristics specific to linguistic behaviour by virtue of this theory being authentically linguistic in the first place. "[His] attack on behaviourist theories of verbal behaviour was centred around his claim that the attempt to assimilate the acquisition of a language to other forms of learning or of acquiring skills made it impossible for these theories to account for precisely those central and specific features of language which constitute its specific difference (for example the fact that a speaker of a language has the ability to produce and to recognize a 'virtually' infinite set of novel well-formed sentences in that language)." (Mepham, 1973, p.110).

another and which, within a domain, explains the production of the diverse and apparent arbitrary variations. Thus an appeal to analogy cannot function as a principle of explanation in the absence of a theory satisfying the analogy by reference to similarity of forms of internal coherence. However, this demand for specificity should not be taken to rule out the possibility that any two or more sciences may be integrated or influence each other at a later stage of development. In fact, it is a precondition for that.

The demand for a theoretical critique of empirical facts (continues Mepham, p.114) is a vital one. It can be viewed as a consequence of the principle that coherence is of the order of theory and not of fact. In other words, "a theory may require us to use new criteria for deciding, in relation to observed phenomena, which are to be taken as the same, or similar to, each other, and which different".

The specificity of a discipline is not, however - to paraphrase Agrest and Gandelsonas (1977, p.105) who use the word 'code' instead of theory - defined solely by the specificity of its theories, but also by the form in which these theories are articulated. That is to say, the articulation of theories may be specific, although the theories themselves may or may not be specific to the discipline in question.

"Examples of specific code articulation in architecture are found in classical theories of harmony that utilize the articulation of musical codes and arithmetical proportional series for the invention of specific *architectural* codes, which are then used to determine the proportions of and relationships between the different elements of a building."  
(Agrest and Gandelsonas, 1977, p.105, their emphasis).

Thus, still paraphrasing Agrest and Gandelsonas (p.106), specificity manages to maintain the limits of architecture despite the apparent changes that occur under the pressures of history, technology, social action, or symbolic change. On the one hand, the more specific theories remain within the context of architecture; on the other, the less specific theories link architecture with other systems (for example, engineering) through the opening and closing of its limits. This mechanism allows for the articulation of architecture with some systems and not with others.

Thus it is not sufficient to claim that architecture is analogous with another discipline, but to show in a specific manner how architecture absorbs but transforms the theories, the models and so on of that discipline so that what architecture has in common with it enters into architecture in a form which is specifically architectural and *vice versa*, otherwise the transposition of these theories and models and their use become both suspect and hazardous.

### 1.3 THE SYSTEMATIC DESIGN METHODS MOVEMENT (SDMM)

Contemporary attempts to extend the limits of architecture and open its boundaries to outside influences have presented themselves in different guises, but found their clearest expression in the 'Systematic Design Methods Movement' (SDMM) of the 1960s<sup>6</sup>.

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6. *The SDMM, of course, claims a huge literature including proceedings of several specialized symposia (for instance, Broadbent and Ward, 1969), special expository and review books (for example, Jones, 1970; Broadbent, 1974) and the lengthy bibliographies these refer to.*

From its inception, the SDMM relied heavily on imported models and analytic techniques (basically of operations research descent)<sup>7</sup> as a means for an objectivist rationalization<sup>8</sup> of conventional design and its transformation into a thoroughly scientific activity<sup>9</sup>.

'Design' was apprehended as a universal process underlying every man-made artefact, thus architectural design, industrial design and so on belonged to one and the same process. In effect, the 'design process' became more important than its particular products. It was viewed as being guided by objective criteria, the end product of which was a logical consequence (in an inductive/positivist sense) of an entirely problem-solving activity. The choice between the alternatives generated by it was in the province of a parallel 'decision-making process'. In consequence, any design problem could be formally presented and solved in terms of a programmatic step-by-step logical progression of well-defined activities. Initially, this took the form of a linear pattern (cf Alexander's first theory), but later modified to embody a cybernetic-like feedback mechanism

7. *With the computer to perform the extensive calculations involved, the major problem seen remaining was efficient computer-programming and problem representation. This particular aspect of consideration, of course, has since attracted much attention in relation to the development of computer-aided architectural design (CAAD). Coupled with it is the continued preoccupation with the question of the division of design tasks between the human designer and the machine. (See Mitchell, 1975, for a discussion).*
8. *See Skolimowski (1972) for a comparative discussion on concepts of 'objectivist rationality' and 'anthropomorphic rationality' and the importance of the latter within the context of architecture.*
9. *The insecure epistemological foundations of the SDMM have been analysed by numerous authors. (See, for instance, Hillier et al, 1972, for a comprehensive treatment). What is presented here is a brief recapitulation of the basic underlying assumptions.*



(leading to the well-known analysis → synthesis → evaluation → decision loops), with the synthetic steps nested inside 'black-boxes' or performed by unaccounted for 'creative leaps', thus rendered mysterious. The systemic-theoretic logic (with its elements, attributes and relationships trilogy) provided the generalized perspective within which the problem could be decomposed into elements or decision areas and the generated subsolutions (the specifics) recomposed into an optimal or nearly optimal determinate solution (the generic). As a result, problem formulation and problem solution were posited as distinct from each other, the solution or part of it could never exist before or coincide with problem formulation. The start was always a fresh one purged from all past influences. Finally, of all the paradigms that could give meaning to architectural form, the functionalist one in its deterministic and behaviouristically predicated epistemology was unquestionably accepted. Design criteria were to be defined *a priori* as functional requirements or more abstractly as 'tendencies' or 'needs' and form was to be developed to fit these needs in a non-contradictory fashion.

Criticisms, within and without the movement, have since been wide-ranging<sup>10</sup>. First, of all the modern shifts in architectural theorizing, the SDMM proved by far the most poor in its practical consequences and effects. Ironically, it provided its own internal paradox when its highly prescriptive data-based programme faced

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10. Examples include Daley's (1969) philosophical critique of the strong behaviouristic component and the myth of quantifiability associated with it; Simon's (1969; 1975) objection to the stringent optimality requirement and his replacement of it by the 'satisficing' criterion; Rittel's (Rittel and Webber, 1973) criticism of the sharp dichotomy drawn between problem formulation



unsurmountable technical and procedural problems. For instance, the invoked mathematics which would solve the combinatorial aspects involved in yielding optimum solutions (even at the objectivist level so specified) still awaits full development<sup>11</sup>. Equally unhelpful was the supposedly complete synonymy of the act of designing buildings and that of designing other man-made objects. This, to a great degree, obscured the fact that, through their accumulation on land and their permanent relationship to fixed sites and so on, buildings represent some peculiar design problems (technical, socio-economic and so forth) which firmly differentiate them from other products of design and hence complicate the design process by which they are produced, beyond and above many other man-made objects<sup>12</sup>.

A most hotly contested feature is, of course, the uncritical prestige to which the so-called 'scientific approach' was held and the canvassing of its methodological procedures in order to guarantee the objectivity and rationality of the solutions which were sought. This proved deficient on more than one count. First, the assumed isomorphic analogy between the physical sciences and architecture proved somewhat difficult to elucidate. In fact, it

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- 10 (cont). *and solution generation and his characterization of design problems as being 'wicked' and, therefore, inaccessible to exhaustive formalism; and finally, C. Alexander's (Preface to the 1974 edition of Notes on the Synthesis of Form) rejection of his own first theory and its replacement by a theory of 'environmental patterns' (Alexander et al, 1967; 1977) in which patterns can be discovered without going through strictly stated formal procedures of the kind he developed earlier.*
11. *A recent assessment of developments in this type of mathematics and the algorithms it provides is given by Lewis and Papdimitriou (1978).*
12. *The major characteristics of building as a product and its differences from other design products have been well analysed by Turin (1966). See also Appendix I.*

seems more reasonable now to contend that architecture exceeds any such science, in the sense that, while it shares with science a fundamental interest - through theories, models and so on - to describe, explain and comprehend the reality falling under its domain, it reverses this process in order to initiate - through the deliberation of those (lay and professional) who practice its design - an undeniably value-laden action aimed at modifying and transforming the environment, thus effecting wholly new realities as yet non-existent. Curiously, even when it behaves like a descriptive science, architecture still spends much time describing the results of its own practice. Its empirical facts are not entirely given, they are also constructed and reconstructed through human deliberations. This is an inherent structural quality (though shared by other design disciplines). It may perhaps explain the paradox of the continued discrepancy between what might be considered at first sight theoretically valid descriptions and the incorporation of those descriptions within design procedures which are appropriate to produce everyday architecture.

Second, even if the scientific approach *per se* is a methodology which is applicable to architecture, it still remains difficult to access, since an agreed account of its workings and its logical and epistemological characteristics has so far proved insoluble<sup>13</sup>.

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13. *Equally inconclusive is the ongoing controversy within the established disciplinary perspective of the philosophy of science. The debate is many stranded and has ranged from K. Popper's anti-verificationist and initially very stringent (but later modified) 'falsificationist and critical rationalism'; to the late I. Lakatos' 'methodology of scientific research programmes' (a sophisticated and subtle modification of the Popperian perspective); to T. Kuhn's 'paradigmatic' perspective; to P. Feyerabend's 'anarchist' one; and what there is in between (for instance, M. Polanyi's 'tacit knowing'). The details of the opposing arguments need not be laboured here, but a useful forum is Lakatos and Musgrave (1970).*

The elucidation and modelling of these characteristics have been complicated by considerations of the purposes of conducting enquiry and of the uses made of scientific theories which are just as important as the logical characteristics of the theories themselves. Further, whatever account is given, it remains basically a *post hoc* rationalization of what logicians and philosophers *think* scientists are doing rather than an ascertained fitting perspective of what scientists *really* do (Meehan, 1968, p.6).

Perhaps the only sound conclusion which may offer a reconciliation of the different opposing views,

"is to state frankly that the object of science is cognition and that it is the strategems of science that are directed towards the real or empirical world. More precisely, we could say that science is about 'remaking cognition', it being clear that if we were satisfied with our cognitive codes for deciphering the world, we would not have science."  
(Hiller et al, 1972, p.7).

What this implies is that the construction of a viable scientific theory cannot be a passive exercise, but that it almost amounts to a reconstruction of reality in terms of a dialectic between the scientists' prestructuring of the world and the world as it shows itself when examined in these terms. Therefore:

"Why not accept that only by prestructuring any problem, either explicitly or implicitly, can we make it tractable to rational or empirical investigation?"  
(Hiller et al, 1972, p.10).

And that:

"The application of a theory to the explanation of many of the phenomena falling within its domain is bound to be speculative, to be an imaginative exercise and not an exercise in deduction and calculation, and thus to be such as

to constitute a demonstration of the potential richness and power of the theory and not a parade of acquired and unassailable results." (Mephram, 1973, p.105).

These are the kind of arguments which severely disrupted the SDMM claim to scientificness and led to its gradual dissolution. But although it is almost superseded now by more realistic views of the design process, it is only fair to credit it at least with one lasting influence. It has raised the degree of interest in the design process to an unprecedented level and in doing so brought to architecture a new concern about theory and methodology (Bazjanac, 1974, p.17) - a concern which is likely to prove more productive in the long run than any practical consequences the movement itself may have produced.

Emergent views on the design process reflect a conviction that the problem-solving activity relating to specific design problems represents only part of a more complex phenomenon, that there exists in any design process an underlying structure whose total nature encompasses aspects outside that particular problem. This implies that any description of the design process should somehow introduce the designer as a cognitive subject right from the beginning and grant him the full facility of his past experience, his privately-held beliefs, the highly synthetic cognitive schemata he abstracts from the architectural environment and the kind of prestructured knowledge he has already acquired. The solution he produces should be viewed not as an equilibration to some atomistic inputs, but as a reflexive result between the cognitive knowledge he holds and what he thinks it is possible to

achieve within the problem situations to which he attends. Thus the main object of new architectural research should be to concentrate on influencing and enriching that type of prestructured cognitive knowledge and the form in which it is held.<sup>14</sup>

Such views have been outlined extensively in the recent literature. Of considerable value to this thesis are the studies (of which the above paragraph is a synoptic view) of B. Hillier and his co-authors on the concept of 'prestructures', that of L. March on the 'abductive/inductive/deductive' trilogical nature of the design process and that of P.G. Raman on the 'unspecifiable and tacit' aspects of it. There will be occasion later, particularly in Chapter 8, to consult these as well as other similar accounts when expounding this thesis's argument in relation to the concept of the 'architectural prototype' as a key-link between theory and practice.

#### 1.4 THE ANALYTIC SPATIAL DESIGN THEORY (ASDT)

In terms of space, the basic philosophy that has underlain the SDMM can be found intact in the 'Analytic Spatial Design Theory'

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14. *As yet the new conceptualizations do not reflect an entirely homogenous design theory. Indeed, they do not all originate from within architecture. Their origins equally belong to other disciplines, but mainly those which give significance to cognitive and socio-cultural processes.*

(ASDT)<sup>15,16</sup> which ran concurrent to it. It was equally dependent on a wide range of derivative techniques and imported constructs (mainly from the field of operations research) and promoted a comparable justificationist argument for objectivity, systematicness and analytic rigor, thus drawing to itself the same kind of general criticism as the SDMM. However, the ASDT subsumed other features peculiar to itself. For instance, it was mainly concerned with fitting patterns of activity to patterns of space or *vice versa*. Within its perspective, the fundamentality of space to architecture was taken for granted. Nevertheless, the epistemological implications of this assumption were never explored explicitly nor a clear definition of the concept of 'architectural space' given.

Layout planning and activity structuring represented an intermediate level. On the basis of this, the theory could operate and mediate the relationship between the institutional identity of, say, buildings and their environmental characteristics, or between their software and their hardware structures. But in doing so, it obscured the inevitable contradictions and anomalies the simultaneous consideration of these aspects (i.e. activity, environmental, institutional and so on) usually generates<sup>17</sup>.

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15. Other pseudonyms include, of course, words like 'layout planning', 'space/activity allocation' and so on. For relevant lists of bibliographies and general surveys, see, for example, Eastman (1975); Mitchell (1977); Cross (1977).

16. The whole theory, of course, now falls under the province of CAAD. However, the issues of CAAD as such are outside the scope of this thesis, but for a discussion on basic theoretical foundations, design potentials and problems involved, see, for instance, Bijl (1977); Mitchell (1977).

17. Being of different substances these aspects are not amenable to the same descriptive language.



There have been many methodological and technical difficulties with ASDT. One particular manifestation of these has been the huge number of alternative techniques introduced and the continuous increase in their complications. And with the recent subscription (for instance, in the work of the Liverpool School<sup>18</sup>) to numerical taxonomic theory<sup>19</sup> and the proven mappings of its method and techniques onto graph-theoretic terms (Hubert, 1974; Hartigan, 1975; Jardine and Sibson, 1971), the list of possible applicable techniques may extend endlessly.

However, taxonomic theory or cluster analysis as such could not offer a relief to ASDT from the profound conceptual problems basic to it and defined by its concrete formulation. Indeed, the heavy methodological burden placed on taxonomic theory seems highly unwarranted. It is clear that since each graph-theoretic criterion defines a rather *natural* concept of what constitutes a cluster and since the definition of a connected graph varies from it being maximally connected to it being minimally so, any final selection by an applied researcher or theoretician of a clustering criterion must be somewhat arbitrary (Hubert, 1974, p.290). In other words, taxonomic theory (cluster analysis, pattern recognition and so on) has no settled epistemological perspective which would relieve those who borrow its techniques from the responsibility

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18. See, for example, Whitehead and Carter (1975; 1976).

19. This has been variously referred to as *theory of classification, cluster analysis, pattern recognition, Q-analysis, clumping, typology* and so on. The variety in nomenclature may be due to the diversity of the fields of application. Some active fields include biology, psychology, artificial intelligence and information retrieval. The classic text on the subject is, of course, Sokal and Sneath (1963).

of ascribing meaning, interpretation, individualization and so on to the particular phenomena they apply them to.

"The chief problem for these theories [of taxonomy, pattern recognition, cluster analysis and so on] has been the mechanism of classification itself: does one identify a chair as a chair by detecting the presence of certain critical features, by matching the input of a prototypical template for chairs, or perhaps by synthesizing an internal model of a chair and matching it to the stimulus? *The issue may not be decidable.*"<sup>20</sup>  
(Neisser, 1976, p.74, my emphasis)

Hence the decision, for instance, on space/activity delimitation and isolation can only be pragmatic and operationally pre-defined. It is not subject to any single-valued logic because such a logic consciously or unconsciously denies the collective environmental, institutional, and so on, context in which any building exists and acquires its identity. This identity by no means reflects a complete solidarity of building as a system, but also it embodies the contradictions and anomalies within and between its different images.

Furthermore, there is no need to take a rigid view on space:

"Space is neither absolute, relative nor relational in itself, but it can become one or all of these simultaneously depending on the circumstances.... The problem of the proper conceptualization of space is resolved through human practice with respect to it. In other words, there are no philosophical answers to philosophical questions that arise over the nature of space - the answers lie in human practice."  
(Harvey, 1973, p.13)

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20. See also Polanyi (1975, pp.51-53) on a brief history of the philosophical problems involved.



## 1.5 CONCLUSIONS

In spite of the contributions which the SDMM and the ASDT made in raising the level of interest in theory and methodology in architecture and in spite of making problems of space central to architectural theory today (a valuable contribution in itself), they have both failed equally to make sufficient links to real-life practice and recognize the potential and limitations of design action. They simplified an extremely complex situation when they claimed they were attempting to rationalize it through imported methods and techniques. They also tended to reinforce the tendency to concentrate on entirely surface and contingent phenomena, while in dealing with them they went to a high level of abstraction which lost all comprehensiveness and compromised their problem-solving capacity.

To point out the difficulties that faced them through uncritical importation is neither to blame the parent disciplines nor to assert that attempts at consulting other disciplines should in any way be abandoned. On the contrary, in the interdisciplinary climate prevailing today, such attempts are unavoidable and are worthwhile, so long as they make their wider theoretical frameworks explicit and do not lose sight of the problem characteristics of architecture and the complex issues peculiar to its practice. Significantly, this thesis takes its share from other disciplines in order to elucidate its argument. But as it does so, it remains committed to what might be called the 'prototypic level of consideration'. This is an intermediate level of consideration at

which a successful mediation between the theory of architecture and the practice of it is to be sought. It suggests that a 'structural approach' which recognizes the 'syntagmatic',<sup>21</sup> character of architectural structures and their prototypic manifestations can be effective in two ways. On the one hand, it provides a comprehensive descriptive framework on the basis of which architectural phenomena can be adequately characterized and explained. On the other, it identifies the practical role played by architectural prototypes in solving everyday design problems as they emerge in time. Therefore, the bulk of the knowledge, theory or technique sought from other disciplines should be directed mainly towards elucidating this level of consideration and towards identifying, developing and enriching the empirical content of these prototypes.

This question will be explored repeatedly throughout this thesis and closely argued in relation to questions of space. The remaining three chapters in this part attempt to lay the foundations to this, through discussing and reviewing some specific issues that are relevant to space.

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21. *What is proposed here is that as far as meaning and evaluation are concerned, architectural structures do not constitute anything but 'syntagms', in which the 'syntactic' component cannot be isolated from the 'semantic' one. However, the use of the term syntagm in relation to architectural structures, though recognizes its linguistic origin, exceeds its technical (in terms of linearity and so on) definition in linguistics. See Chapter 6, especially.*

## CHAPTER 2

### ARCHITECTURE AND THE HISTORICAL EMERGENCE OF SPACE-CONSCIOUSNESS

#### 2.1 INTRODUCTION

However elusive the idea of 'space' in architecture might prove to be, it is generally agreed now that space is an intrinsic medium through which architecture - both as a discipline and as a practice asserts itself. It is strongly argued also that the difficult situation in which architecture finds itself today is essentially a result of a problem with space (Glanville, 1976, p.18). To the extent that this is true, the ongoing architectural debate has produced a wide variety of space conceptualizations. Yet, the epistemological status and nature of the combined structure 'space/architecture' is far from being well defined. A possible reason might be that the notion of space itself, consciously formulated, is comparatively new to architectural theorizing and that it may take some time before a coherent architectural theory about it can be evolved.

In this chapter, it is suggested that central to an enquiry into this notion is the enquiry into the history of its coming into being. The emphasis laid on tracing this history is not without significance. Many theoreticians (significantly across all

disciplines) recognize the fact that the historical origin and past developments are indispensable to the understanding of an idea or a concept in the process of acquiring epistemic import. This history, by its very nature, constitutes a positive contribution and convenient source of appropriate information out of which it may be possible to anticipate any subsequent epistemological or methodological developments that concept may undergo.

Obviously, a comprehensive investigation into the 'total history of space' as an architecturally conceptualized and materialized phenomenon belongs to the general history of architecture. This still has to be written and there is no room here to follow its basic constitution in any great detail. Instead, interest will be focused on outlining a much more recent aspect of this history. This is what might be referred to as the emergence of 'architectural space-consciousness'. Although this space-consciousness has emerged only recently, its short history has been rather dramatic and has certainly ensured that space is the one problematic that dominates every serious architectural debate. An immediate reminder of this recent history may perhaps improve the understanding of the impact it has had and continues to have on modern architectural theories.

## 2.2 THE PRE-HISTORY OF SPACE-CONSCIOUSNESS

According to Collins (1965, p.285), until the eighteenth century, no architectural treatise ever used the word 'space' and

the idea of space as a primary quality of architectural composition was not fully developed until recently.

"What mattered to Classical theorists, in an age which defined architecture as the art of building, was structure, and this did not necessarily imply the enclosure of space, but might equally well be a solid object such as an obelisk or a triumphal arch (where space-enclosure was non-existent or negligible). Complex sequences of inter-related courtyards and rooms, incorporating extremely subtle spatial relationships, were often built by Classical architects; but these were only discussed by theorists in terms of structure and proportion, and if the word 'space' was used at all, it was only with respect to their decoration, to indicate amorphous unproportionable surfaces, such as the blank areas of a painted ceiling, and had no three-dimensional significance whatsoever." (Collins, p.285).

However, the fact that there were no well articulated *conscious* architectural conceptions of space in the past, should not be taken to imply that past architectures were completely lacking in concepts that pertain to space. On the contrary (Glanville, 1976, p.18), there have always been indirect concepts of space that have usually been formulated in ritual descriptions (formalized or otherwise) of ordering and organizing systems. For instance, in Muslim architecture a building whose orientation is not set towards Mecca is anything but a mosque. The role played by the shape of the cross in guiding church planning can also be cited, as well as numerous other examples<sup>1</sup>. The argument here, however

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1. A repeatedly used model has been that of the human body because of its familiarity and immediacy. Within the documented literature of architecture, it has featured in (among many) the work of Vitruvius, Leonardo da Vinci and in modern times in Le Corbusier's *Modulor*. Its influence still continues prominently in the form of both perceptual and anthropometric models.

(to paraphrase Glanville, p.18), is that all these devices describe approaches to and ways of handling space, rather than consciously defining what space is to architecture. In this way, for example, aesthetic concepts of symmetry, proportion, the orders and so on are not specific descriptions of architectural space, although when implemented they define spaces. And while modern aesthetics seeks a firm grounding in perceptual/cognitive psychology (Hesselgren, 1969; Arnheim, 1977), its present reduced role is likely to continue. This is because as space gets increasingly treated as a commodity which is subject to market forces, its evaluation becomes dominated by more urgent factors, such as economic ones.

### 2.3 THE BIRTH OF SPACE-CONSCIOUSNESS

According to Collins (1965, p.285), the change from Classical conceptions towards a more marked space awareness, probably first occurred in the middle eighteenth century as a result of the introduction of 'romantic gardens'. Here the spaces, though equally amorphous and difficult to subject to formal proportions, say, as building surfaces, clearly had a more positive quality than being mere flat surfaces. Nevertheless, the word '*space*' itself was seldom used even in this context. It did not begin to come into fashion with any precise three-dimensional sense until the mid-nineteenth century. Moreover, its introduction into the history of architecture derives entirely from its use by German theorists

in the same century.

"The German comprehension of the significance of architectural space, or *Raumgestaltung* (i.e. the spatial design of rooms as opposed to the solid surfaces circumscribing them) doubtless resulted to a large extent from native perspicacity, but it can also be attributed to the interesting linguistic coincidence whereby the German word for 'space' is similar to the word 'room'. Thus it required no great power of the imagination for a German to think of room as simply a small portion of limitless space, for it was virtually impossible for him to do otherwise. We thus find, from the beginning of the nineteenth century, a number of German writers on aesthetics using the term 'space' in its modern architectural sense. The best example is Hegel, whose *Philosophy of Art* (based on lectures given in the 1820s) contains numerous uses of the term, as when he refers to buildings as 'limiting and enclosing a defined space' or describes a Gothic church as 'the concentration of essential soul-life which thus encloses itself in spatial relations'. This somewhat mystical notion of space was developed to its greatest extent as a technique of art criticism by the German art-historian Heinrich Wölfflin, and it is probably through his English-speaking disciples that the idea spread through the Western world." (Collins, p.286, his emphasis).

However, it was Frank Lloyd Wright's contribution which proved most decisive to the establishment of modern architectural spatial developments and of the emergence of space-consciousness.

### 2.3.1 The Contribution of Frank Lloyd Wright

It was Wright who, around the beginning of this century, first exploited the spatial possibilities which had lain dormant since the end of the Baroque (Collins, p.286). He swept aside



the idea of rigid spatial compartmentalization and based his conception of space on continuity. For him continuity was a natural objective, the very substance of organic architecture.

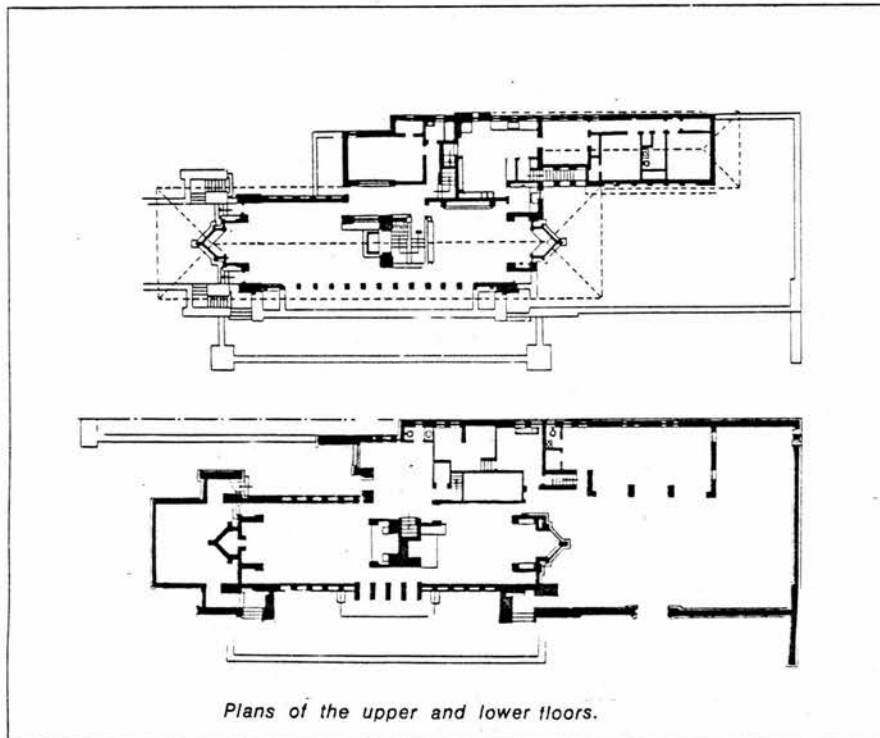


Fig. 2.1 Frank Lloyd Wright: Robie House, Chicago, 1909. (from Norberg-Schulz, 1975, p.349).



"Through the idea of continuity came the idea of flowing space. Flowing space brought different ideas together to combine and form a new idea. He called this organic design. A continuity of idea: natural idea: growing idea: living idea: organic design. For the first time space was not confined within four walls. Walls were eliminated. Doors were found unnecessary. Space began to expand into other space, so that when you stepped into a space, you were really not aware of its size. Part of it disappeared around to the left, part of it over a case on the right, so that you didn't know where the area ended. This did a great deal to increase the effectiveness of space without increasing actual space. Space not only went this way and that way, but it went up and over into another space, so that no matter where you were or which way you looked you never did see all of the area around. Part of it is always reserved for exploration. Even a building and garden can be tied thus together so that the inside becomes part of the outside, the garden becomes part of the building, and the building becomes part of the garden."  
(Dow, 1963, p.24)

This does not imply that his space conception was in any way inarticulate or undisciplined. Quite the opposite, he repeatedly and consciously used grids in a sophisticated and subtle manner. His grid planning was associated with his ideas on construction and his belief that the nature of materials should be allowed expression as part of the whole process of the building becoming what it wanted to become. Thus he allowed structural and constructional ideas to influence form, but not to cut drastically across spatial requirements (Jones, 1978, p.18).

### 2.3.2 The Contribution of Mies van der Rohe

Mies' conception of space showed itself most clearly in the Barcelona Pavilion (1929). This brought to reality the concept of space with which he had earlier experimented through a few

buildings and several projects, especially the Brick Country House Project of 1923. In the Barcelona Pavilion, he dissolved the ordinary elements of enclosure-floors, walls and ceilings - and reconstituted them as abstract planes divorced from structural functions. Thus he obtained more spatial freedom than if these elements were structural. This, of course, progressively developed into the fully-fledged 'open-plan' and so-called 'universal space' (most clearly expressed in the 'pavilion') with no fixed spaces apart from stairways, lifts and utility spaces.

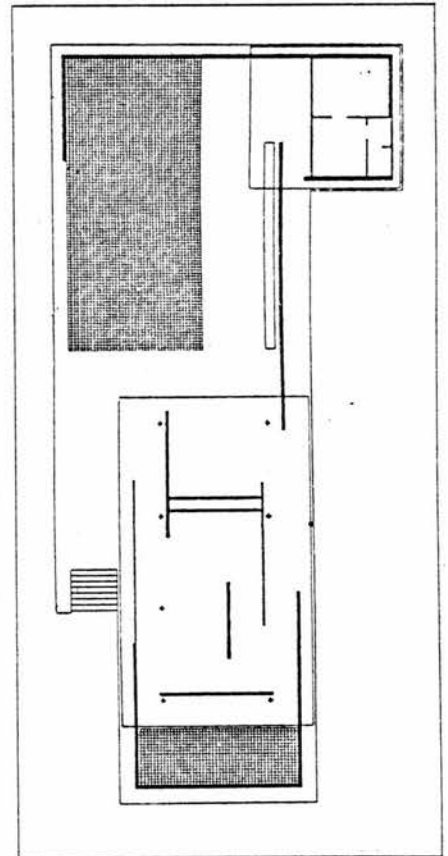
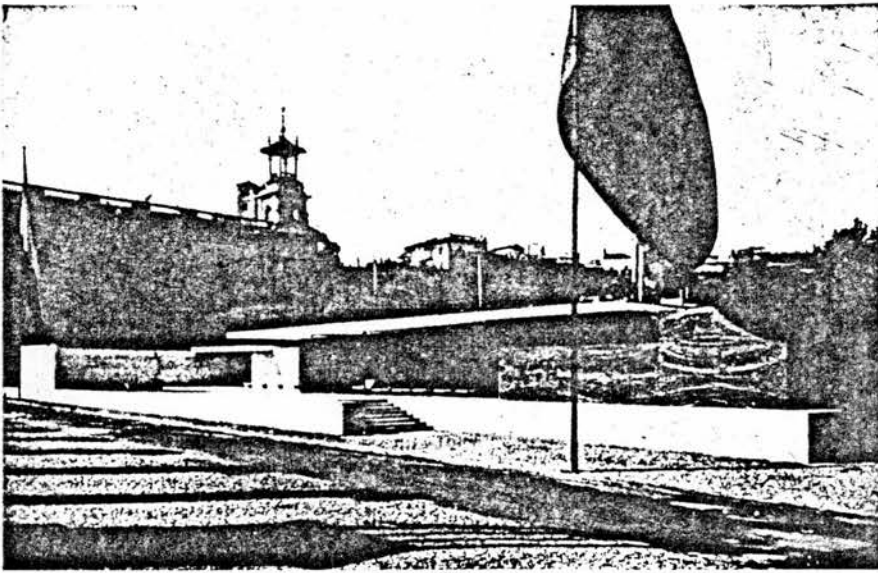


Fig. 2.2 Mies van der Rohe: German Pavilion, International Exposition, 1929, Barcelona. (From Norberg-Schulz, 1975, p.365).

The severe criticism of his almost Platonic insistence on purity of form and his resolute suppression of everyday practical use and functioning of building is well known.

"Mies ... imposes upon reality a metaphysical order of his own. Even this dilemma might be soluble if only the ideal world for which Mies designs his buildings corresponded more closely to the real one. Unhappily, it does not. He has created an architectural order, imperturbable and implacable (the adjectives are those of his admirers) for an ideal landscape. Nothing ever happens here. It is airless, timeless, filled with light - but not sunlight, since it has no heat, no direction, no fluctuation of color and intensity; no gales howl here, no dust blows, no insects fly. There are no excesses of summer humidity or drifting winter snows. There are no preferred orientations or exposures, since there is no weather in his compassless world. In sum, Mies designs for the golden climate of Plato's Republic - but he builds in Mayor Daley's Chicago." (Fitch, 1963, p.161).

Nevertheless, Mies' role in shaping the concept of space was central to its whole modern development. He achieved a synthesis of the two main innovations of the nineteenth century: the open repetitive order of skeleton construction and the fluid, but articulate space of Wright (Norberg-Schulz, 1975, p.364). This synthesis was anticipated by Le Corbusier, but brought to its logical conclusion by Mies (for example, in the Barcelona Pavilion)<sup>2</sup>.

### 2.3.3 The Contribution of Le Corbusier

The contribution of Le Corbusier to the articulation of the concept of space in architecture was equally important, if not more decisive, particularly in his original recognition of the

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2. *Unlike the other Great Masters, Mies wrote very little. His ideas were mainly worked through graphical prototypic projects and the buildings he designed. These remain the major source for investigating his ideas.*

structural relationship between skeleton construction and open space.

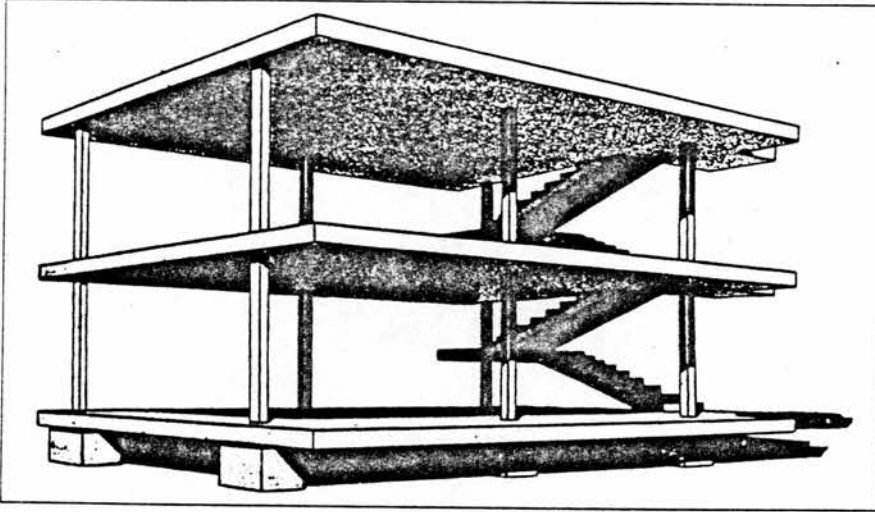


Fig. 2.3 Le Corbusier : Dom-ino, 1914. Standard Framework. (From Norberg-Schulz, 1975, p.363).

This eventually developed into his now famous five points of the 'new architecture'; the *pilotis*, the *roof garden*, the *free plan*, the *strip window* and the *free facade*. In these he listed the advantages of the new approach to space conceptualization and consequently he defined the general properties of 'functionalist building' (Norberg-Schulz, 1975, p.363). It was not only the application of these principles in some of his buildings (for instance, the Villa Savoye at Poissy, 1928-29) which was important, but also their combination with his relentless activity to develop particular architectural prototypes<sup>3</sup>. A case in point is his long research on the standard dwelling ("a house

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3. *The development of prototypes was an activity in which the other Great Masters were also actively engaged.*

is a machine to live in"), which culminated in the building of the *Unité d'Habitation* at Marseilles (1947-52) with its complete spatial regulation on the basis of the *Modulor*.

However, in accordance with his capacity for change in both thought and practice, Le Corbusier undermined many of his own principles<sup>4</sup>. For example, in Ronchamp (1953-55) he used no ribbon windows, no pilotis, no roof garden, and no free facades. What remained was some measure of a free plan as a gesture to the nature of the project. But in doing so, he showed his ability to explore new spatial possibilities. The most striking one among these was his exploitation of window size, shape, depth and glazing in conjunction with daylighting.

#### 2.3.4 The Consolidation of Space-Consciousness

Thus with efforts like those of Wright, Mies and Le Corbusier and with the birth of the International Style, space was no longer unconsciously derived but regarded as central to every architectural undertaking. A significant aspect of those early efforts was the fact that they followed a dual process of development. This process included theoretical and practical/experimental aspects. The practical related to real-life practice in the form of the

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4. Jencks (1973, p.141) observes that there is a fundamental difficulty, which all critics seem to encounter, when trying to interpret and judge the work of Le Corbusier. They do not know exactly what standards to apply - whether rationalist, poetic or both. They all seem to work to a point and then fail to be conclusive.

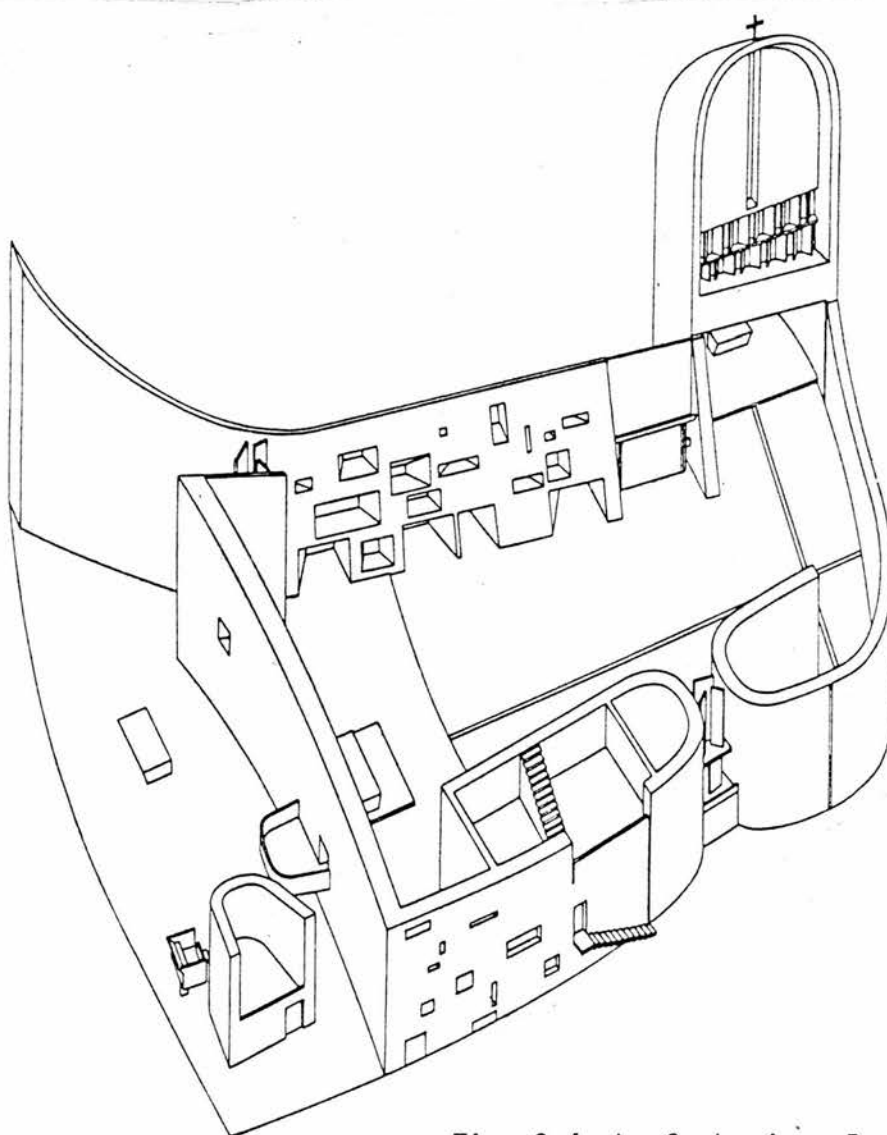
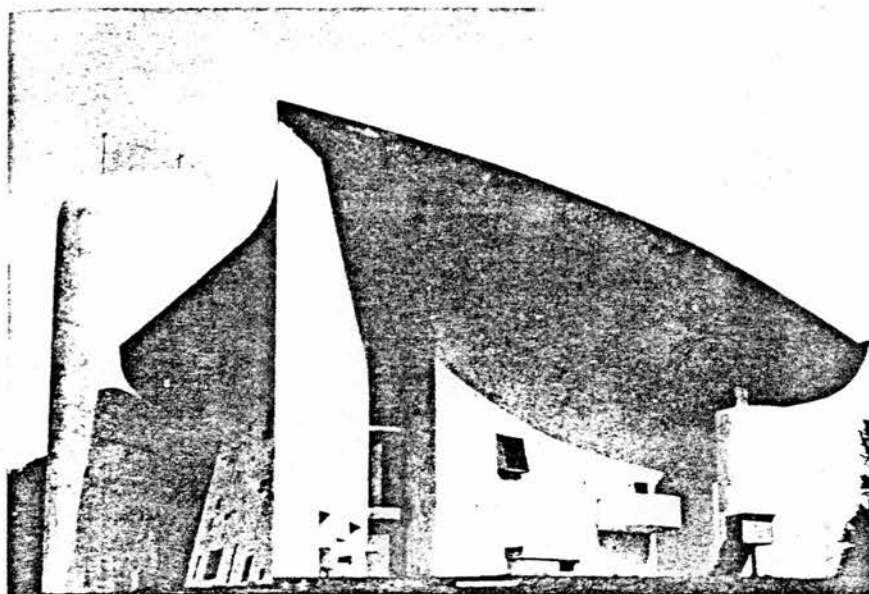


Fig. 2.4 Le Corbusier: Ronchamp, 1953-55. (From Jencks, 1973, p.155)

various buildings being built. The experimental took the shape of graphical prototypical projects (a valued cognitive method in architecture through much of its history and an essential tool in its teaching). Both were useful as testing and discovery procedures in relation to the theoretical assumptions advanced.

## 2.4 HISTORICO-THEORETICAL CONTRIBUTIONS

Afterwards, however, the purely theoretical side of the above process became increasingly more dominant<sup>5</sup>. This, of course, is more obvious in architectural research today. Nevertheless, an important line in theoretical activity has been the historico-theoretical one (Giedion, 1941; Zevi, 1959; Panofsky, 1960 and so on). In this connection, the contribution of Giedion remains the most influential. First, it has provided an important generalization. Secondly, it has established space as a necessary component in formulating new architectural theories.

### 2.4.1 The Contribution of Giedion

The generalization produced by Giedion (1941, 1964, 1971) refers to his now much acclaimed idea that the concept of space,

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5. *An early post-contemporaneous theoretical contribution was Moholy-Nagy's conception of space as 'experienced space' which was linked to the concept of the 'biological'. Its functionalist behaviouristic nature cannot be missed. In retrospect, it must have been influential (though it rarely gets cited in the relevant literature) in creating the kind of climate in which much of the recent behaviouristic space formulations have flourished. See Moholy-Nagy (1937) and also Banham (1960, pp.316-9) for further details.*



although only recently named, had always been present in architecture and had taken quite different forms at different times. He viewed the history of architecture as a succession of three space conceptions. The first (Ancient Egypt, Sumer and Greece) was brought into being through the interplay between volumes. The second (from the Roman Pantheon to the eighteenth century) was synonymous with hollowed-out interior space. The nineteenth century formed an intermediary link. The third space conception (the twentieth century) retained the second's idea of hollowing out interiors, but freed space from the restrictive bounds of wall-barriers. Movement has been incorporated into this as a direct response to the influence of the automobile.

Although Giedion's own concept of a 'space-time' (an Einsteinian phase) in architecture or its relation to other analogies has proved somewhat problematic and thus much disputed<sup>6</sup>, his statement on the role played by space in understanding the built-environment has served an important purpose. On the one hand, it provided a concept which has since been effective in the reinterpretation of the history of architecture<sup>7</sup>. In this respect, the influence of his method of historical analysis has been wide ranging. On the other hand, it has helped to make questions of space central to all new theoretical and practical enquiries in architecture.

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6. See, for example, Collins (1965, p.288).

7. A recent example is Norberg-Schulz' (1975) attempt to analyse the history of Western architecture in spatio-cultural terms.



## 2.5 CONCLUSIONS

While this survey is obviously an oversimplification, it is hoped that it provides sufficient evidence for the epistemic importance the concept of space has achieved in modern architectural practice and theorizing. It reveals through the consideration of a few historical instances, the way in which the understanding of the concept was consciously sought, articulated and assimilated by the discipline. And although the various views on the subject do not reflect a unified idea of what exactly space is to architecture, they have gone far beyond classical aesthetic specifications. They have discussed space in relation to other concepts, such as structure, organicness, continuity, flexibility, function, culture and so forth.

In the general historical literature, these are discernable polarities in terms of the 'rational' and the 'organic'. Yet, this may not be the most important observation in history. There appears to be a more valid level at which the impact of the different contributions can be held and evaluated. In the first place, these contributions have ascertained that no new architectural theory could seriously avoid making known its views on issues of space. This is the epistemological achievement.

In the second place, it is very difficult to assess the contribution of men like Wright, Mies and Le Corbusier who pioneered the new space conception through a purely theoretical history. That is, their ideas cannot be evaluated entirely on the basis of their rhetoric, but most importantly through the series

of changes the concept underwent as a result of their real-life actions. Their commitment to architecture (through its practice) was total. They offered tangible testimony (successful or unsuccessful) to what they said was important to it. Consequently, their theories (even when they did not work) remained architectural and can be judged as always being so.

This is a situation which is increasingly rare today. An acceptable justification is the prohibitive cost of conducting real-life experiments during theoretical enquiry. Nevertheless, the possibility still exists whereby the empirical content and practical effectiveness of theory can be increased. This is where the idea of the architectural prototype may be of direct help. It may provide a key-link between theory and practice as it has always done throughout the long history of architecture. The argument for this usefulness will become clearer as this thesis progresses<sup>8</sup>.

In the next chapter, however, the historical survey is carried further by reviewing a number of space formulations which are comparatively active now in the field of environmental research. Their relevance to specific issues of architectural practice forms part of the investigation.

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8. *Part III of this thesis elaborates on this point, while Part IV develops a practical example.*

## CHAPTER 3

### ENVIRONMENTAL THEORIES OF SPACE: A CRITICAL REVIEW OF SOME RECENT FORMULATIONS AND THEIR APPLICATIONS IN BUILT ENVIRONMENT STUDIES

#### 3.1 INTRODUCTION

In this chapter a number of different approaches to the study of 'artificial space' are reviewed. Generally, these approaches are of a descriptive or explanatory character. Their intention is to achieve a better understanding of the workings of spatial structures either as they are said to exist morphologically in the artificial environment or in our perceptual/cognitive capacity to conceive of them. Most of the approaches, however, hope that such an improved understanding will eventually initiate a more effective design practice. In reviewing them, a main aim is to identify a variety of concepts and terminological tools which have been evolved and which (at least in theory) offer useful insights into the nature of artificial space. These may then serve as convenient points of departure for further investigation.

Parallel to this, however, it will be suggested that most of the approaches, important as they are, still remain pre-operational insofar as they continue to function at a purely



descriptive level and do not involve specific issues of design practice. This criticism is essentially methodological. It argues that a general descriptive account of the nature of artificial space, though valuable, is not enough in itself to generate appropriate design knowledge if it is not closely linked to the issues of the very practice which produces that space.

This introduces the requirement for a broad structural framework which besides being relevant to the description of the artificial environment as such, is also concerned with the operational character and problem-solving capacity of the descriptive tools it employs and consequently the knowledge it produces. A framework of this kind has been termed here a 'syntagmatic framework'<sup>1</sup>. It is based on the assumption that design action, because of the immediacy of the phenomena it deals with, occurs predominantly at the synthetic level of consideration. Thus to be operationally effective, an architectural theory needs to accept a less deep level of abstraction than the syntactic one for describing environmental structures. This is the syntagmatic level. Its basic tool is the 'syntagmatic pattern' in which prototypes which are highly structured can exist on a multidisciplinary basis and can be used both as a basis for describing complex architectural structures and also for designing them.

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1. *The syntagmatic framework accepts the necessity of syntax as an organizing principle in any coherent system, but also recognizes that there is a level equally as deep as the syntactic one at which the 'semantic dimension' is also originated and operates. This even goes as deep as the level at which the basic syntactic rules are formulated. Its strategy is not to argue the primacy of one dimension over the other, but to investigate (within the context of the system under consideration) the dialectical involvement of each in generating the necessary conditions for existence of the other without being reduced to it. See Part II, Chapter 6, especially.*

The different approaches to the study of artificial space, however, are too many to cover in detail here and for the purpose of the present discussion it is more convenient to examine them under a few categories of general formulations. These have been classified in terms of: psycho-humanistic, syntactic, semiological, and combinatorial/configurational formulations. Extended references have been made to the work of K. Lynch and Norberg-Schulz in relation to the first; to the work of Hillier and Leaman and their co-workers for the second; and to the work of L. March et al, P. Steadman et al and R.T. Atkin for the fourth. The references made to various authors in relation to semiological formulations have been limited to general comments only, due to the rarity of concrete models.

### 3.2 PSYCHO-HUMANISTIC FORMULATIONS

The different approaches to spatial understanding which involve the human body (as a percept, a schema or an organizational system), the human mind (in a perceptual/cognitive sense) or both are given a variety of names. To some extent, these names express the stresses placed on one aspect of consideration or another. For convenience, the generic term of 'psycho-humanistic' formulations has been adopted here.

There are two identifiable sub-categories of these formulations. The first is mainly based on psychology. Here man is seen to experience the environment as a psychological being,

hence the general field of 'environmental psychology'. However, there are two quite separate bodies of literature<sup>2</sup> relating to environmental psychology; one (which takes precedence)<sup>was</sup> originated in the field of psychology proper, the other in the various environmental disciplines, such as behavioural geography, urban planning and architecture. Both address the same basic issue: how do we come to know and experience the form of space and how does this aid our spatial behaviour and actions. Nevertheless, each has its own specific area of concern.

The work carried out under the field of psychology is usually conducted within the confines of micro-scale environments with the emphasis on identifying the exact nature of the psychological mechanisms involved in spatial perception and cognition, while the work under the environmental fields is mainly concerned with extending the application of these perceptual and cognitive mechanisms from the study of small objects placed in confined and limited environments to the study of spatial systems defined within wider environmental contexts - including neighbourhoods, cities, regions and so forth. The interest of this thesis is, of course, limited to <sup>the</sup> built environment and its spatial systems and it is from this perspective that the contribution of the environmental fields is viewed. For convenience, this contribution may be grouped under the sub-title of 'spatial cognition and <sup>the</sup> built environment', where cognition includes

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2. *This literature involves contributions from numerous disciplines. There are attempts to bring this literature closely together and evolve an area of unified concern and application. See Downs and Stea (1973), for an early representative text.*

perception as one of its modes of operation.

The second sub-category of psycho-humanistic formulations makes the same appeal to psychology, but supplements this by a philosophical argument which is essentially existential and phenomenological in character. However, research under both sub-categories argues its case within the assumption that to humanize the environment, the subjective values people attach to it should be given priority.

### 3.2.1 Spatial Cognition and Built Environment

Within the environmental fields, Lynch's (1960) *The Image of the City* provided the first elaborate experimental study which gave impetus to much subsequent research into spatial cognition of large-scale environments. It introduced a number of experimental techniques and spatial concepts and then systematized these within a built environment perspective. Its most important spatial concept has been that of the 'urban image' and its deployment as form.

#### 3.2.1.1 Lynch and the urban image

Lynch says he is concerned with the 'look of a city'; in his conception, its 'imageability'. He takes imageability as basic to 'legibility' - that is, "the ease with which the parts of a city can be recognized and can be organized in a coherent form" (Lynch, pp.2-3). Any urban image has a series of precise

physical contents that confer on it an *identity* linked to a *structure* or *pattern* and possessing *meaning* (Lynch, p.8). There are five physical elements or features of the urbanscape which constitute the basic vocabulary for forming intelligible images. These are paths (movement channels), districts (distinctive areas), edges (boundaries to areas), nodes (strategic foci) and landmarks (single prominent elements) (Lynch, pp.47-8).

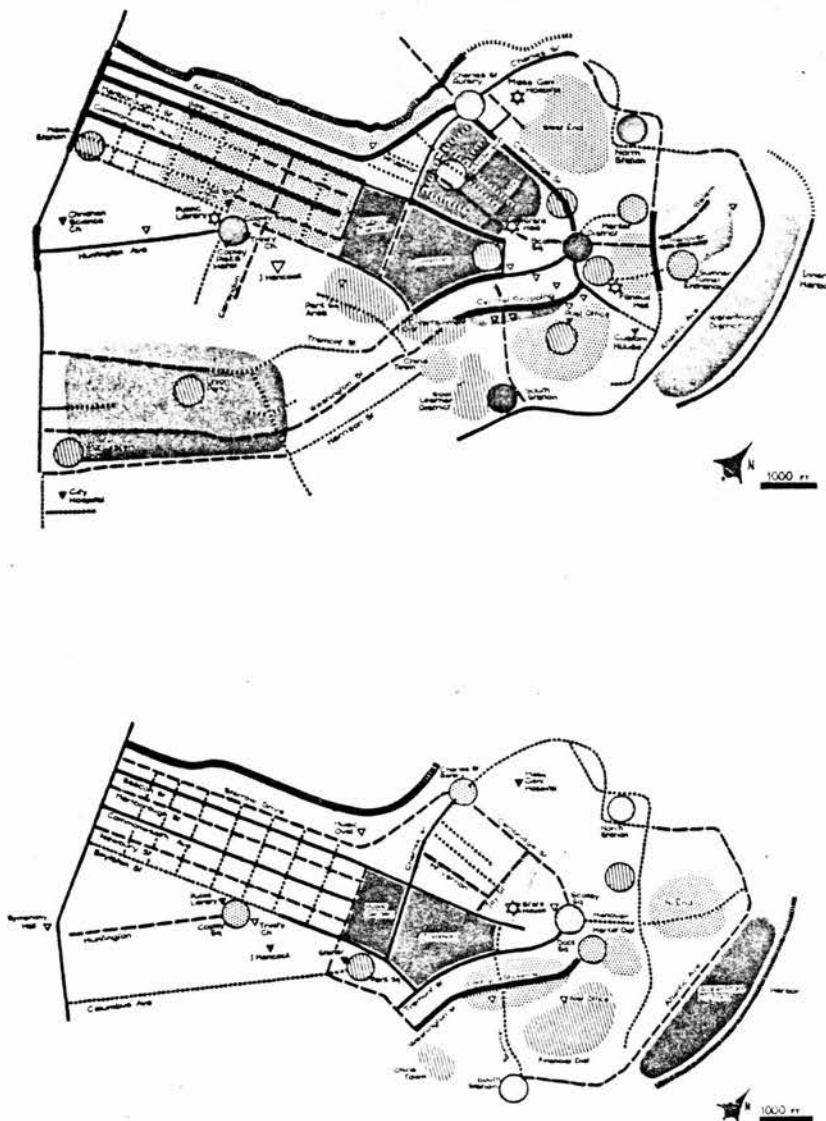


Fig. 3.1 The collective image of Boston derived from: (a) verbal interviews; (b) sketch maps. (From Lynch, 1960, p.146).



Lynch's work is based on a purely communicative consideration of the built environment. It does not consider the *process* by which the built environment itself is produced nor does it consider the social meanings and functions involved in it - despite its strong awareness of their importance<sup>3</sup>.

"This analysis limits itself to the effects of physical, perceptible objects. There are other influences on imageability, such as the social meaning of an area, its function, its history, or even its name. These will be glossed over, since the objective here is to uncover the role of form itself. It is taken for granted that in actual design form should be used to reinforce meaning, and not to negate it."  
(Lynch, p.46)

Nevertheless, the operative value of the images developed on the basis recommended by Lynch when actually planning or designing a city or part of it is not immediately accessible. Despite their involvement of physical elements, the images themselves do not by necessity constitute part of the designer's prestructured knowledge. This is because the construction of these images is highly subjective and dependent on their definition by other individuals, and their definition by different individuals or even groups needs to be constantly discovered and

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3. *Castells (1977, pp.216-7) points out that, although the identity of an image and its possession of a structure may remain within a pure deployment of forms (referring to one another according to a code), the introduction of meaning necessarily brings into play the process of production of these forms, their insertion in a socially determined content. There is thus a contradiction between Lynch's approach which is 'designatory' implying an autonomous logic of forms and the results of his analysis, which refer constantly to a social meaning that is always external and consequently largely arbitrary. Further specific discussion of Lynch's work can be followed in Appendix I, pp.322-3.*

externalized. The problem of how they can be objectified and made design-operative remains largely unresolved.

A major aspect of this kind of problem is that of *representation*. There are many difficulties associated with drawing conclusions about the ability to move and act spatially from information regarding the ability to give schematized representations of that space and *vice versa* (Harvey, 1969, p. 193). The dangers involved in confusing the perceptual level with the representational level, in fact, have long been recognized in the field of psychology and its associated fields. For instance, in their work on the developmental conception of space in children, Piaget and Inhelder (1956; summarized in Harvey, 1969, p.193) have emphasized the importance of distinguishing between perception of space and the representation of space by imaginary concepts. They suggest that the ability to represent space schematically is influenced by culture and the existence of signs and symbols designed to represent that space. In some cases, the jump from perception to schematic representation may not even be achieved if the appropriate representational tools are culturally lacking.

Pocock and Hudson (1978, p.47), therefore, argue the need for a broad theory which, on the one hand, would ideally link the structure and content of the image to the process that produces images, while, on the other, it would link the structure and content of that image to some form of observable behaviour. That is the image must be seen in both its socio-cultural and functional context.

### 3.2.2 Humanistic (Existential/Phenomenological) Formulations

Besides embodying a psychological dimension, this type of formulation equally subscribes to existentialism and phenomenology. To differentiate itself, particularly in the geographical and planning literature, it calls itself 'humanistic'<sup>4</sup>. Central to its view of space is the concept of 'place'.

#### 3.2.2.1 Space as place

*Space as place* is defined as a centre of meaning or a focus of human emotional attachment and the affective patterns of identification with places, irrespective of their scale, are taken as the object of investigation. In fact, the claim has been made that,

"when the experience of places is taken as a focus, then the scale does not have qualitative significance." (Canter, 1977, p.3).

Methodologically, therefore, the environmental scale at which investigations are conducted may vary from object-tokens, such as beds in hospital wards, to regions and countries. Underlying the exploration of such a wide range of spatial units is the assumption

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4. *Influential work in the geographical/planning literature is spearheaded by E. Relph (for instance, his 1976) and Tuan (for example, his 1974; 1975; 1977). For a comprehensive review of this literature and a good explication of the concepts involved, see Entrikin (1976).*

that the psychological processes involved are similar (Canter, 1977, p.2). Consequently, there seems to be a growing consensus to take particular units of the environment as synonymous with places, while space becomes a 'system of places'.

Important to the conception of space as place is the concept of 'existential space'. Entrikin (1976, pp.625-6) gives a general summary of definitions of this concept. *Existential space* is taken as the 'concrete' space of man's primitive and original contact with the world; his bodily presence in the world. It is a non-geometric space of human concern and involvement. It represents an 'intentional network' which connects objects of concern with the intentional consciousness ('egocentric space'). At a larger scale, existential space represents an area of shared meaning and value for a group, such as a neighbourhood space or national space.

However, despite its recent popularity in the geographical and planning fields, the direct impact of the humanistic perspective on architectural theory proper - apart from the limited influence of the work of Norberg-Schulz - seems negligible.

### 3.2.2.2 Norberg-Schulz and the concept of existential space

For Norberg-Schulz (1971; 1975; 1976), the most important notion is that of existential space and its possible transformation into architectural space. He defines existential space as *space symbolizing man's being in the world*. In order to attain

architectural significance, existential space is linked to the physical environment symbolically through constituent elements (places, paths and domains). As symbolic forms, these are determined by the interaction of man and his environment. These elements can be manifested at different environmental levels, ranging from the level of the landscape to the urban level of human settlements and finally to the level of single buildings or parts of them.

Although the conceptual investigations of Norberg-Schulz are of considerable exploratory value and offer useful insights into the concepts he introduces, the applied qualities of these concepts (at a methodological level) still remain unspecific in terms of concrete architectural practice. This is a limitation which extends to the whole area of psycho-humanistic studies.

### 3.2.3 The Contribution of the Psycho-Humanistic Perspective Evaluated

An inspection of the available literature suggests that the majority of psycho-humanistic spatial studies do not explicitly involve a sociological dimension. Most of the models (considered as behavioural models; Buttimer, 1972, p. 285) rest heavily on generalizations about relationships of humans to their environment, but they do not involve the social processes by which the artificial environment itself is produced.

In its present form, the psycho-humanistic perspective can

only progress if it is seen as a form of criticism (Entrikin, 1976) or else if its stronger concepts are assimilated or accommodated by theories of greater power and high empirical content. As a form of criticism it has challenged and continues to challenge the excesses of purely formalistic theories. It has questioned their basic premises in a manner which has highlighted the gaps and over-simplifications they make in treating such complex and socially evaluated phenomena as those of the built environment. Additionally, it has reaffirmed the importance of the study of meaning and subjective values by drawing attention to the fact that design is about people and not mere objects. Hence its humanizing influence and the anthropocentrism it implies will continue to be worthwhile.

On the conceptual level, a series of major concepts has been evolved. The meanings assigned to these concepts are not standardized or unambiguous<sup>5</sup>, but as tools for general understanding they are of considerable value. Within the context of this thesis, the concept of 'schema' (especially as 'spatial schema') is an important one. Though it is only a loose interpretive model, it does have distinctive cognitive properties that are not found in other models of perception, memory and programming of

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5. *Studies attempting to clarify the concepts involved include Lee (1976); Pocock and Hudson (1978); Tuan (1975). What seems to be agreed upon is that all these are mnemonic devices which help build the same theoretical framework through which empirical investigations can be conducted. The idea is that theoretically people use these devices to classify and organize sense-data for the purpose of navigating paths through space, locating themselves and other objects in space and coordinating their activities (Cullen, 1978, p.399).*

behaviour (Lee, 1976, p.182). And while in its original inception it had no specific morphological properties, it has since acquired implications of morphology and dynamism. Its major advantage to this study lies in its power to clarify the concept of the architectural prototype. Reciprocally, the concept of schema itself can be made increasingly operative in design terms. An equally significant concept which is also helpful to this discussion is that of 'image'. Its role in relation to the other two concepts is discussed below.

#### 3.2.4 Schema, image and prototype

As a psychological concept, 'schema' has its development mainly in the work of Bartlett and later in that of Piaget and, Inhelder. According to Lee (1976, pp.182-3) - who is widely credited with introducing the concept into the field of built environment studies and originating the concept of spatial schema<sup>6</sup> - Bartlett (1932) used the term schema in a wide sense, although mainly in relation to remembered material and the inner templates that appeared to form as a result of the development of skilled activity. His central theme was that there are internal representations upon which an individual draws as a reference when attempting to construct, say, a picture. It is this generally accepted set of expectations which enables people to produce a drawing and also contributes to its distortion (Canter,

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6. See, for example, Lee (1963; 1968). One major characteristic of spatial schemata is that they include areas and places never experienced, but known indirectly through information.



1977, p.13). Piaget and Inhelder (1956; Piaget, 1971) have also developed the concept of schema in a similar fashion, but made more explicit the means by which new experiences are incorporated into it. Two *equilibration* processes are said to be involved. The first is 'assimilation'; the second is 'accommodation'. Assimilation refers to the incorporation of new and different experience into already structured schemata. Accommodation involves reflexive modification and readjustments of existing schemata in the light of new experience. The two processes work simultaneously, the one complementing the other.

However, to acquire a strong morphological dimension, a schema may be viewed as incorporating a representational pattern of the structure of something as well as a pattern for action on it, either in the abstract by manipulating representational symbols or in real life by actually doing something physically. Within this definition, the concept of image may be introduced. Both terms, schema and image are occasionally used interchangeably in the literature. A popular definition is to see image as a mental representation of that part of reality known through direct or indirect experiences, grouping various attributes and combining them according to certain rules (Rapoport, 1977, p.115). Yet, it seems more productive to consider images as components of schemata. In the sense that if a schema is considered as a field or multi-dimensional structure, then images refer to specific descriptive modalities embedded hierarchically within that structure. More precisely, there seems to be no obvious need to



lay strict conditions that direct experience must always be involved in constructing or acquiring schemata or images. It should be possible to develop these through whatever means are possible including direct experience or objectified means such as education, reading, information and so on - together or singly. Of course, the more of these are involved (especially direct experience) the richer and more accurate the image or schema may tend to be, although the danger of it becoming confused or distorted is also there.

In short, an image can be seen as an internal representation, construct or understanding of *an aspect* of an existing or presumed reality according to some *particular* objectified or even personal (subjective) model of investigation or 'way of seeing'. This means that *an image is reductionist*. It is *limited by the specific descriptive substance it employs* to construct itself. For instance, if an object is studied, experienced or apprehended on a geometrical basis, then a geometrical image is obtained and (for the time being at least) this image may tend to dominate all other potentially obtainable images of that same object. In terms of architecture, for example, an architectural structure may have an activity image, an environmental or an institutional image. It may also have subordinate images which come under these. What is important, however, is that an architectural schema is more than any of these images, but may incorporate any one of them or all of them together. It may also accord predominancy to one over the others. In this sense, a schema has a higher qualitative

content than an image; though it is constituted by images. But while a schema or an image may be related to the physical organization of, say, an environmental object, none of them necessarily coincide with it. They somehow remain at a distance from it. And that distance is a source of interpretation and meaning.

In a preliminary form, the relationship between the concept of the architectural prototype and schema can be viewed as follows. A prototype may be taken as synonymous with a schema insofar as it is conceived as an internal or deep level construct in which different images of an architectural reality are well structured and incorporated. However, unlike schemata, prototypes are not entirely psychological. The concept of prototype can be extended to incorporate a highly objectified content including the possible realization in terms of concrete objects, such as buildings. This is not to argue that a prototype is necessarily a building, but, on the other hand, any building can be investigated as, or modelled on, a prototype (see Section 6.4 and also Chapters 8 and 9). A prototype may also manifest itself in the form of a design project (or a design schema) and so on. In other words, a prototype may be internalized in the form of a design schema by individuals or groups, but still it may manifest its existence outside individuals as such altogether. Thus knowledge about prototypes can be gained by studying the built environment itself or by studying design action or biographical accounts of it, or even by innovation in terms of speculative or concrete research programmes. By definition, a comprehensive architectural prototype must include (in some hierarchical fashion)

an activity, environmental and <sup>an</sup> institutional image<sup>7</sup>.

### 3.3 SYNTACTIC FORMULATIONS

Structural analogies drawn between language and architecture, with language as a base, are generally designed to establish closer morphisms between the two. The aim is to aid the investigation of complex architectural structures by drawing on models of language since these have proved productive in many other areas of research. Formally, the Chomskyan version of the modern linguistic theory of syntax has provided a popular model for these analogies. With respect to artificial space, the 'space syntax' model of Hillier and Leaman and their co-authors can be discussed as a well developed example.

Some of the theoretical considerations which underlie the space syntax model originated in Hillier and Leaman's earlier work. Much of this earlier work was concerned with characterizing the design process and the kind of prestructures that make design possible<sup>8</sup>. The significance of the arguments connected with this to the project of this thesis have already been acknowledged (Section 1.3) and will be further clarified in due course (Section 8.2 in particular). However, because of the specificity of the space syntax model and the projected attempt to develop it into a formal

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7. *This discussion is elaborated at various instances in the remaining parts of this thesis, particularly Part III.*

8. *See especially Hillier et al (1972); Hillier and Leaman (1974a).*

theory of space applicable to both architecture and society, the discussion here will be mainly concerned with it in the form in which it has been concretely formulated, especially in its latest version (Hillier et al, 1976).

### 5.3.1 The Space Syntax Model of Hillier and Leaman and their Co-Authors

The space syntax model represents an attempt to develop (through a selective merging of linguistic and mathematical considerations)<sup>9</sup> a formal language - said to be a member of what are termed 'morphic languages' - on the basis of which a series of generative/descriptive patterns are drawn. These patterns are then used to investigate the spatial structures of existing human settlements and complex buildings. In the same manner, it is hoped that these particular patterns will provide a means for the comparable investigation of the social deployment of society in space; the argument being that:

"Morphic languages are the realisation of abstract structure in the real world. They convey 'meaning', not in the sense of representing something else, but only in the sense of constituting a pattern. Thus if, as we believe, both space organisation and social structures are morphic languages, the construction of a social theory of space organisation becomes a question of understanding the relations between the principles of pattern generation in both." (Hillier et al, 1976, p.152)

Invariably, Hillier and Leaman (the senior authors) adopt the

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9. *The qualification is made (Hillier et al, 1976, p.152) that morphic languages differ from both natural and mathematical languages, yet fall between them and borrow certain properties from each.*

view that elementary space organization structures are barrier-structures whose evolution towards higher structural degrees may be described by functional variables - such as contiguity, differentiation, boundaries and permeability - and operational rules (fundamentally aggregational) aiming at transforming simpler structures into more complex ones (Hillier and Leaman, 1974b). The key to their analysis lies in the concept of the 'internal transformability' of an object according to a morphic system which defines two structures called the 'deep' and the 'surface' structures. Both structures are conceived in a manner which is epistemologically analogous to their definition by Chomsky (1965). Chomsky says that, in a linguistic system, deep structure is partly defined by,

"Universal rules [the rules of grammar] which specify an abstract underlying order of elements that makes possible the functioning of transformational rules ... that map deep structures into surface ones."  
(Chomsky, 1965, p.141)

This transformational process preserves the deep structure, however complex or varied the surface one becomes. In effect, the deep structure is to be taken as to *constitute* the fundamental conditions for the existence of the surface one. This distinguishes the 'structural approach' from the 'systemic' one as far as intelligibility is concerned (Hillier and Leaman, 1974a, p.6).

The space syntax model postulates a syntactic component in architecture which would be capable of generating both deep and surface structures (through transformations). It accepts the concept of syntax in its general epistemological nature, rather



than in its narrowly technical linguistic definition of constituting principles of combining words (in a linear fashion) to form *grammatically correct* sentences. It defines syntax in morphic languages as,

"a set of related rule structures formed out of elementary combinations of the elementary objects, relations and operations."  
(Hillier et al, 1976, p.150).

Now, the general cognitive value of the concept of syntax is undeniable. By this is meant the idea that *structure* cannot be found at the surface level of overt observable relations, but must be deductively attained through abstraction and the construction of models of the system of organizational principles that underlies, regulates or generates surface phenomena. Such a view is productive in explaining the successive transformations of structure from the elementary to the complex ('complexity chain') at a certain level of investigation. It can be successfully employed to show (as indeed the space syntax model has done) that a series of apparently disconnected surface phenomena are internally related insofar as they are derived from the same basic deep elementary structure - irrespective of the particular transformational histories of their coming into being in the real world. Theoretically, it shows that *knowledge* of syntactic patterns, although not necessarily always conscious, at least partly underlies design action.

An important question is whether in the sphere of everyday



design practice it is necessary to postulate that purely syntactic patterns underlie design action. By definition a formal model like the space-syntax model is reductionist. Its immediate link with real problem-situations remains difficult to identify; it being too general and too abstract to support any specifiable empirical content. Within its own premises, it may succeed in giving reasonably accurate descriptions of spatial structures of artificial space, but its ability to deal with differentiation of descriptive substances (such as the activity, environmental, institutional and so on) is likely to be limited. It can only operate at synchronous levels of consideration, therefore, incapable of explaining *in what precise way* a structure is transformed from a deep to a surface one ('deepness chain') *at a particular moment in time*.

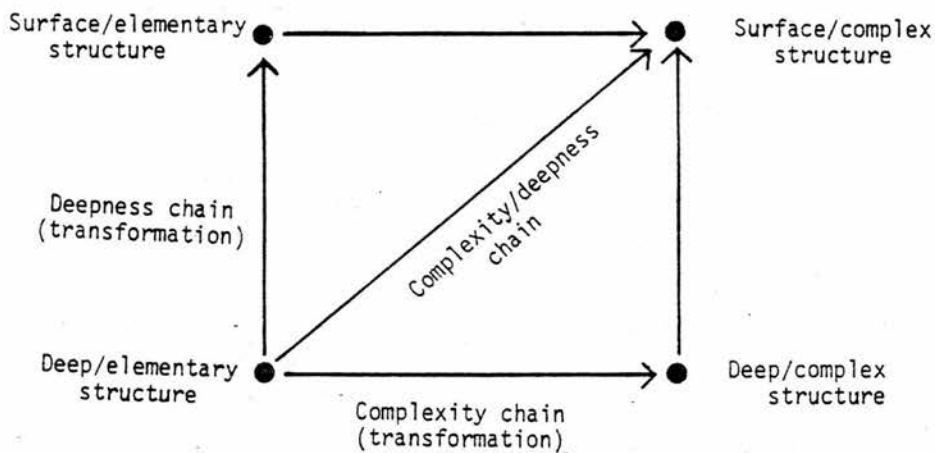


Fig. 3.4 Deep and surface structure; complexity and deepness chains

Now, if it is accepted that design action is organized primarily to conduct historically specific modes of material appropriation, then it is obvious that the realization of the abstract deep



structure in the real world is neither entirely random nor a purely syntactic formal process. It is also intentional and governed by socio-cultural processes which are historically originated and have a logic which is by no means entirely *spatial* or limited to the production of artificial space as an isolated product. Other influences relate to the kind of technologies used, the ideologies involved and the specific kind of natural environment that is supposed to be modified. Therefore, design action is predominantly articulated within what might be called a 'semantic universe', in the sense that the production of meaning is both its start (its programme) and its most important result.

In general, what a purely syntactic strategy usually results in is to resolve the relation between deep and surface structure by giving primacy to the former and its purely syntactic logic. But it is important to remember that the transformation of the deep structure into a surface structure ('deepness chain') is a semantic process and it is the surface structure which is ultimately effected by design action. A particular surface structure is, furthermore, a choice among many. Therefore, the act of designing it involves *evaluation*. But this act of evaluation (which is essentially a semantic act) must intervene long before that particular surface structure is effected. This can only happen at some deep level of consideration. In effect, it belongs more to the deep structure than the surface one and must, therefore, have rather serious repercussions on it and on its syntaxes<sup>10</sup>.

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10. *Incidentally, recent linguistic research also seems to show that semantic considerations have considerable repercussions on syntax at the very deep levels of utterances (Chomsky*

Operationally, real-life design action is much constrained (if only by time) in its ability to posit an autonomous deep structure against an autonomous surface structure (which anyway does not exist at the moment of design) and explore all the possible mappings between them. This might potentially be possible in a science which is only interested in description and has all the kind of surface phenomena that interests it available to it, but not with a design science - especially at the moment of its practice and when it is initiating a new reality. Therefore, the deep structures which underlie design action must be highly synthetic in character (where both the semantic and syntactic dimensions have been integrated) and much easier to evaluate, if they were to find immediate application.

Thus the problem of how the semantic dimension is related to the syntactic dimension and how to identify the appropriate level of abstraction where the deep structure is defined both syntactically and semantically is a very important problem in any attempt to produce design knowledge which is effectively operative. This appropriate level of abstraction has been called here the 'syntagmatic level' - the level of highly structured prototypes and synthetic design schemata. (see Part II, especially Chapters 6 and 7).

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10. (contd) *himself now recognizes this). This makes the complete isolation of any level of the linguistic system and/or structure methodologically inadequate (Wilden, 1972, p.232). See also Leech (1974) and Appendix I (particularly, Section 4) for an elaboration on this point.*

### 3.4 SEMIOLOGICAL (OR SEMIOTIC) FORMULATIONS<sup>11</sup>

Studies which investigate the built environment semiologically are now widespread and although space is a common theme (Rapoport, 1975), the subject matter is mixed and wide ranging. Studies extend from concern over the nature of architectural elements, such as staircase, door, window, column and the like (for example, Eco, 1972); through concern over the nature of whole buildings (for instance, Jencks and Baird, 1969; Norberg-Schulz, 1963); to concern over the nature of whole human settlements (for example, Lagopoulos, 1975). Others are concerned with analyses related to media - graphical representations, models, verbal descriptions and so forth - used in the design process. An emerging area of

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11. *In the related literature, the terms semiology and semiotics - despite their common etymological origin (the Greek word semeion meaning sign) - do not mean the same thing to their respective adherents. The reason is the independence of their epistemological origins. The term 'semiology' has been founded in the Saussurian linguistics. It was envisaged to designate a future science of sign, the conceptual basis and methodological apparatus of which would be guided by linguistics as a pilot science and modelling perspective. 'Semiotics' (originally, termed in the singular 'semiotic') has its major origins in the philosophy of C.S. Peirce (with his well-known trichotomies - famous among which is the sign triad, of icon, index and symbol) and that of C.W. Morris (with his well-known division of the field into syntactics, semantics and pragmatics). It has been posited as a science of sign, but to be developed in a manner independent of linguistics. It has recently (Eco, 1976) been developing towards becoming an all-embracing interdisciplinary science concerned with all systems of communications. In this thesis, however, the term semiology will be generally preferred. This is mainly because much of the well developed linguistic/semiological terminology and concepts have proved (with qualifications) valuable to the overall subject matter which is under discussion.*

concern also is that of textual analysis of the architectural writings of Vitruvius, Alberti, Palladio and others<sup>12</sup>.

### 3.4.1 Architecture as a System of Signs

Semiological studies invariably express the belief that semiology, largely on its own, is capable of providing both a theory and a methodology for investigating architectural meaning as reflected either in architectural products or in the conceptual means by which they are understood, described, produced or expressed<sup>13</sup>.

The general objective which has been postulated by architectural semiologists has been that, through the consideration of architecture as a system of signs and as a systematic and specific way of organizing forms and meaning, more effective architectural knowledge can be produced. Similar claims to the production of effective knowledge have been repeatedly made in other theoretical and critical approaches to architecture (Agregt and Gandelsonas, 1977, p.97). The basic difference between semiology and these other approaches lies in the former's specific attempt to develop models that are consciously intended to take problems of meaning

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12. *For a critical study of the various themes, see Agregt and Gandelsonas (1977).*

13. *For example, Broadbent (1978, p.475): "If all buildings inevitably carry meaning, then we should do well to see how they do it. At the very least, that will help us to understand all buildings better. And if our buildings are going to symbolise anyway - despite our best (or worst) intentions - then an understanding of how they do so may help us design them to do it better. The most promising way of looking at these things seems to be the Theory of Signs which has been developing from the work of Ferdinand de Saussure ... and Charles Sanders Peirce ..." (his emphasis)*

into account and, therefore, make it potentially more productive. Unfortunately, this potential is, as yet, far from being realized.

A major problem has been the unmistakably high degree of involvement of the functionalist paradigm. By implication, most studies claim that they are opposed to functionalism, but closer examination reveals their strong dependence on it in some way or another. For instance, objects in the environment are seen to have inherent meaning which is special to them; thus architectural elements possess meaning that they can communicate and consequently they are treated as signs. The obvious conclusion being made is that architecture can be considered as a system of signs equivalent to other communication systems, such as language.

Conclusions of this kind have been strengthened by the successes made by semiological theory in the fields of linguistics, literary analysis and anthropology. But this overlooks an important fact. In these areas, the semiological model has been *contextually redefined* on the basis of the *empirical realities* associated with these areas (Maravelias, 1978, p.292). It is precisely this contextual redefinition and use of the model that led to their successes as encountered, for instance, in the works of Barthes, Chomsky, Lévi-Strauss and others. Indeed, all three (Barthes, Chomsky, Lévi-Strauss) are strongly opposed to the mechanical transcription of models from one area to another without prior consideration of indigenous theories and phenomena<sup>13</sup>. Barthes

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13. *The relevant views of Lévi-Strauss and Chomsky have been reported in Section 1.2.2.*

(1973, p.112) says,

"Semiology, once its limits are settled, is not a metaphysical trap: it is a science among others, necessary but not sufficient. The important thing is to see that the unity of explanation cannot be based on the amputation of one or the other of its approaches, but, as Engels said, on the dialectical coordination of the particular sciences it makes use of. This is the case of mythology: it is a part both of semiology inasmuch as it is a formal science, and of ideology inasmuch as it is an historical science: it studies ideas-in-form."

In the context of architectural semiology, Agrest and Gandelsonas (1977) express similar views. They present many cases which stress the efficacy of indigenous architectural models, especially those which have their origin in theories of architectural criticism and in the history of architecture. The main argument is that indigenous theories of architecture, through their close relationship with the practice of architecture, might provide semiology with a closer and more direct view of the problems that architects are trying to solve.

#### 3.4.2 The Evaluation of Present Semiological Contributions

Two recent reviews (Broadbent, 1978; Agrest and Gandelsonas, 1977) may be consulted for lists of references and comments on the state of the art<sup>14</sup>. What emerges is that semiological studies in architecture seem to be troubled by two things; first, by the

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14. *Broadbent's paper is rather general and with an obvious aim to popularize the subject. Less so is Agrest and Gandelsonas' article. It is more rigorous and particularly critical of the high level of uncriticality and unspecificity observed in many studies.*

obvious state of confusion and conflict (both conceptually and terminologically) in which 'general semiological theory' itself is engulfed (being still in a state of early development and not yet a well articulated science); second, as observed above, by the very uncritical and somewhat superficial way semiological concepts have been imported and applied to architecture. The result of all this has been reflected in the high level of generality of most of the semiological research so far being conducted and its lack of specific concepts and models appropriate to architecture (Agrest and Gandelsonas, 1977, p.93).

This situation had been aggravated by the negative attitude which accepts the necessity of working entirely within the linguistic framework, while ignoring many basic structural differences between language and architecture<sup>15</sup>. As systems, there are some parallels between them, but this parallelism cannot be stretched too far.

Particularly important to architecture is the fact that environmental artefacts are models having a multivariant nature. They do not have isolated structures assignable to them by an infinite productivity controlled by more or less explicit grammatical rules (Agrest and Gandelsonas 1977, p.95), nor do they contain specifiable encoded meanings which a knowledge of specific codes or their grammar would enable one to decipher once and for all.

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15. *Major structural differences include the principle of linearity in combining linguistic signs and the predominance of communicative value in evaluating them. The first principle as such has no bearing on architecture, while the second is fundamentally secondary to it.*



This is simply because the operations of their production and consumption enable them to be structured in a variety of ways. More appropriately, when a subject assigns structures or forms to them, he does so on what Norberg-Schulz (1963) or Pettit (1975) would call a 'Gestalt basis' or through 'reflective abstraction' in the Piagetian sense, rather than by a definite generative procedure. The generative ability related to language as described, say, by Chomsky's model is probably related to the biological characteristics of man. But, while it would be too difficult to deny the importance of architecture to man, there is no conclusive proof that the production of architecture is a natural act as, say, speech utterances are said to be natural acts. It is obvious that only a limited number of people learn the architectural productive mechanism in a process which should be seen as mainly sociological, rather than coming from man's biological characteristics (Gandelsonas, 1973, p.21).

Therefore, the attempt to consider architecture as a system of signs falling under the sphere of general semiology, and then to take this as being both a methodological necessity and a theoretical claim without justifying either through the empirical realities of architecture or even disentangling one from the other, needs to be resisted. Architecture has long established its legitimacy in practical life. It has its history, its theories and its practices. All of this cannot be systematically distorted for the expedience of a conveniently available parent discipline. Nonetheless, in terms of methodology, a structural analysis which embodies a



semiological dimension is both acceptable and feasible. Furthermore, the difficulties attributed to the majority of semiological applications should not obscure the fact that semiology, with its conscious undertaking to deal with problems of meaning, is very valuable. But to avoid the anomalies which have just been referred to, a methodological shift is required from the commonly adopted analytical attitude, and its preoccupation with devising taxonomic typologies and investigating isolated environmental objects.

#### 3.4.5 The Syntagmatic Strategy

Apparently, the shift in methodology has already begun. A number of studies in the recent literature discuss and develop a new body of architecturally redefined notions that explicitly or implicitly suggest the emergence of new approaches. These approaches (at least in outline) adopt what might be called a 'syntagmatic strategy'<sup>16</sup>, where elements acquire their meaning according to their place in a system (a context) and through their permutation from

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16. *Such a syntagmatic strategy is pragmatic in outlook. It is initially based on the Saussurian gesture that meaning requires structure and that it is generated at the level of syntagmatic formations (that is, in the structural solidarities formed by signs through a set of systemic relationships). However, this strategy completely rejects any idea of the necessity of strict linearity (which is essential to the formation of linguistic syntagms) in the formation of architectural syntagms. What remains essential is that the structural solidarities are to be realized permutatively and are to be investigated at a multiplicity of levels. Furthermore, whatever level is taken or however deep it is, the structure of the syntagm is dual in nature incorporating both a syntactic and a semantic dimension. See Chapter 6, for detailed discussion.*

from one level of consideration to the other<sup>17</sup>.

More generally, it seems to be agreed that semiology furnishes structural analysis with a concept which is decisive in that it makes explicit what is essential to every system of meaning, namely its organization. This concept has been termed by Barthes (1977, p.85) the *level of description*. According to Barthes (pp.85-9) the idea of levels gives two types of relations: *distributional* (if the relations are studied on the same level) and *integrational* (if they are grasped hierarchically from one level to the next). Consequently, distributional relations alone are not sufficient to account for meaning. In order to conduct a structural analysis, it is thus first of all necessary to distinguish several levels or instances of description and to place these instances within a *hierarchical* (that is integrational) perspective. Given such a perspective, analysis cannot rest satisfied with a purely distributional treatment of the units it defines. To understand a structure is not merely to follow its horizontal unfolding, but also to recognize its multi-level construction; to move from one level of consideration to the next. It is integration in various forms then, says Barthes, which compensates for the seemingly

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17. See Awadalla et al (1976; 1977), where an outline of a syntagmatic descriptive framework has been suggested (refer also to Maravelias, 1978, for an elaboration of this within a climatic design context); the self-criticism of Eco (1976) counterarguing his own earlier conception of architectural sign; the general discussion presented by Pettit (1975) in support of an approach to the study of architecture and the non-literary arts through what he terms 'syntagmatic structuralism'; and the many examples cited by Agrest and Gandelsonas (1977) including the recent work of G.C. Argan and their own, part of which is developed as a critique of what they describe as historically emergent architectural ideologies.

heterogeneous and unmasterable complexity of units on a particular level.

A structural analysis semiologically characterized and developed within an architectural context may, then, be carried out at two levels. First a conceptual level which relates to architecture as a science of the study of the built environment and its structures. By necessity such a level is predominantly descriptive. The second level relates to architecture as a practice. It is fundamentally design-specific in character. In terms of space, the conceptual level of structural analysis takes into account the physical (that is environmental) existence of artificial space, but also adds to it the kind of activities it is supposed to accommodate as well as the institutional dimension (depending largely on the system of social evaluation involved), both of which contribute to its understanding. At the design-specific level, structural analysis will be concerned with the artificial space itself, but in relation to its design and production, mainly, but not exclusively, through the preconceptions of those who design it. In general, these preconceptions are based on complex processes which reflect the internalization of equally complex spatial prototypes or schemata in the structure of which environmental, socio-economic, cultural and other aspects of the built-environment have been well integrated. The influence of these ready structured prototypes on any new act of design is initially decisive and it may continue to be so throughout the design process and beyond (at the level of consumption).

However, it will be wrong to see these two levels of consideration as separate: both are central to the subject matter of this thesis and will be repeatedly addressed as the discussion progresses.

### 3.5 COMBINATORIAL AND CONFIGURATIONAL FORMULATIONS

Recent studies of the combinatorial and configurational type reflect a significant shift in attitude. Compared to their optimization-orientated predecessors, these studies are guided by modest objectives<sup>18</sup>. No programmatic claims are made to presenting optimum or prescriptive solutions to satisfy prescribed functional requirements. Instead, the whole idea of drawing specific lists of functions as strict generative bases for architectural layout designs is abandoned. Functions are viewed only as constraints and concern is directed towards defining the limits to possible solutions under such constraints or alternatively investigating what constraints certain solution sets are likely to satisfy. Some solutions may do this (probabilistically) in an optimum manner, but not as a necessity.

#### 3.5.1 The Contribution of March et al

Active research directed by the above shift in attitude is

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18. *Interestingly, even within the applied mathematical sciences on which these studies depend, this shift has already occurred. Lewis and Papadimitriou (1978, p.109) discussing the 'efficiency of algorithms' have identified this: "A more profound compromise gives up not only the requirement that a solution be optimal, but also the insistence that a less than optimum solution be guaranteed to fall within a specific range. Instead the assurance is given that the solution will not deviate far from the optimum."*

represented by much of the literature published in the journal *Environment and Planning - B*, but especially the work of L. March, W.J. Mitchell, P. Steadman and their co-workers. One of the many areas of investigation under this type of research is the study of combinatorial and enumeration problems - the number of ways that spatial elements may be combined and partitioned to give distinct 'designs' and the adaptability of forms to accommodate activities (March and Matela, 1974, p.231). The immediate aim is to show, through employing combinatorial and other associated mathematical procedures, that there are *definable functional limits* to the type of floor plans (based initially on the criterion of adjacency)<sup>19</sup> that are possible and that these are, in fact, countable and enumerable depending on the number of space cells (or rooms) considered. What the work generally hopes to achieve is to provide (statistically) useful profiles, bounds and distributions of adjacency censuses for different populations of cellular forms that are analogous to architectural plans.

This is based on the assumption that:

"...prior to any attempt to solve a particular architectural layout problem it is of value to have studied the properties of certain solution sets even though these are abstract and extremely simplified."  
(March and Matela, 1974, p.196)

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19. *This is taken as a reflection of the intuitive recognition of the rudimentary nature of the concept of adjacency to architecture.*

And further:

"... a designer with a well-understood and structured vocabulary of form is more likely to find suitable matchings with functional requirements than one who attempts to let form follow function in some supposedly self-generative way."  
(March and Matela, 1974, p.212)

For instance, March and Earl (1977), through investigating recent enumeration results in the field of combinatorics and relating them to the problem of counting various classes of architectural floor plans and their adjacency structures, demonstrate the existence of an isomorphism between the set of trivalent 3-polytopes (three-dimensional forms in which three polygonal faces are incident at each vertex) with  $n+1$  polygonal faces and a class of architectural plans with  $n$  rooms - including internal courtyards and the like. They argue (p.59) that such a class of plans is *fundamental* in the sense that *all* architectural plans with  $n$  rooms may be derived from it through *ornamentation*. They conceive of ornamentation in a manner which is consistent with Frank Lloyd Wright's view that ornamentation presents an integral process in architectural design: the material expression and enhancement of underlying structure.

"... ornament is to architecture what efflorescent of a tree or plant is to its structure. *Of* the thing, not *on* it." (Wright, 1953, p.348, his emphasis)

Thus for March and Earl (p.59):

"... room formation is not itself a design problem, whereas ornamentation is. Immanent structures for each and every room formation are finite in number and known aprioristically: architectural design is preeminently a matter of selection and the appropriate physical and material *transformation* of one of these fundamental plans." (Their emphasis)

This, in effect, implies that evaluation is an inescapable aspect of design action. Furthermore, implied in the research programme itself is the notion that functional relations between cells are of a qualitative nature and it is through introducing constraints that the quantitative aspects to these relations can be progressively revealed. For example, the work of P. Steadman and his co-workers (see, for instance, Steadman, 1970; 1976; Mitchell et al, 1976) shows how a dimensioning constraint (within rectangularly dissected plans) can be introduced. The resulting dimensioned adjacency structures (and their elaboration into cells whose areas and parametric lengths are derivable) are amenable to <sup>being</sup> made increasingly specific (and thus of more practical interest) by introducing into them further constraints that enrich their empirical content. Perhaps climatic factors may present the next type of constraints that could be incorporated. Hence the specificity of these adjacency structures, one hopes, can only improve with time and, therefore, become more practical.

Significantly, this type of research illustrates the workings of some important emergent views on the design process<sup>20</sup>. These views recognize the synthetic nature (what have been called in this

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20. *The specific contribution of March to the debate on the design process will be introduced in some detail in Section 8.2.*



thesis the prototypic nature) of design action, the importance of prestructures (whose properties may sometimes be specifiable within certain constraints) and that usually some preliminary solution has to be allowed to emerge before much detailed analysis on problem requirements can be carried out. This is because,

"part of the problem in design happens to be the solution! The 'solution' when arrived at inevitably poses further problems ... Some of these problems arise from the fact that internal conditions cannot traditionally be taken into account until the solution is made explicit. However, this study suggests that at least some internal properties of form can be introduced initially in terms of population bounds .... Thus the extreme bounds for certain properties may be used as internally determined constraints: it is known that no solutions can possess values outside these ranges, and it would be futile to attempt to match some functional need to a population which could not possibly satisfy it."  
(March and Matela, 1974, p.214)

However, it has to be noted that concern within this area of research is still largely limited to the investigation of spatial structures at the environmental level. The more general problem of discussing simultaneously 'spatial' and 'aspatial' structures and how they interrelate at the environmental, activity and institutional levels has not yet been seriously approached. It is only within such a broad framework that the operational character of the adjacency structures enumerated in relation to specific design situations can be fully apprehended. Nonetheless, the related attempt by R.T. Atkin to discuss the interrelation between spatial and aspatial structure, though its degree of success is still difficult to estimate, is worth reporting.



### 3.5.2 Atkin and the Structural Relationship between Spatial and Aspatial Structure

The work of Atkin (1974a; 1974b, 1974c; 1975) represents an elaborate formal attempt to discuss the interaction between *spatial* (referring to the distribution of phenomena in space) and *aspatial* (referring to the interrelation of phenomena within non-spatial - that is political, cultural and so on - frames of reference) structure. This problem was identified by Foley (1964) in relation to his attempt to develop a general conceptual framework for investigating 'metropolitan structure'<sup>21</sup>. Atkin's (1974a, pp.52-3) basic assumption is to view aspatial structure, such as an organization of activities or of social relationships, to exist in a space of its own - not the ordinary three-dimensional space of objects, but the multidimensional space needed to describe the structure. In consequence, he views the mutual interaction of a spatial structure with an aspatial one as itself being a structure describable in a higher dimensional mathematical space. This he considers as providing a fundamental structural basis for the study of urban and architectural structures, and the social processes associated with them.

More generally, Atkin emphasizes the point that, once we decide on the system that interests us, the search for an appropriate topology or algebra is the most crucial step in our effort to investigate that system. In effect, he develops a rigorous mathematical language (the language of so-called *simplicial*

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21. Foley's conceptual framework is made use of in the following chapter, Section 4.6.

*complexes* or *q-analysis*) to which the idea of identifying sets and understanding the structural properties of relations between them is central. The attempt itself reflects a special concern to develop a mathematical structure rich enough to support the mapping of empirical (numerical) observations onto it. The most important aspect to it is that it does not treat 'structure' as merely distributional, but also in a hierarchical manner, where a structure is investigated at some level  $N$ , while at the same time it is recognized that there are immediate levels  $N-1$  and  $N+1$  (and also beyond these) below and above level  $N$  that are important to its appropriate understanding.

Technically, the mathematical language developed is complex and demanding. Nevertheless, despite the richness of Atkin's programme, there remain a number of difficulties which may inhibit its full implementation in a complex system such as the built environment. For example, it is not obvious how a chosen geometrical *backcloth* is arrived at in the first place or how sets are to be defined or their elements identified (much of the phenomena involved is non-digital) or how to put numerical values on whatever *traffic* that is between them. Obviously, what elements appear to signify in relation to a given space is very difficult to identify, since there is no guaranteed isomorphism between an abstractly constructed element and an empirical spatial reality which is likely to contain phenomena in an overlapping manner. Another difficulty is how to make the different estimates on the different *types* of traffic comparable (some may relate to colour,

some to cost, some to distance, some to material and so forth)<sup>23</sup>. Atkin himself recognizes these kinds of problems, and, in fact, despite the stringent demand his programme places on defining sets and their elements, he never suggests or claims that the significance of these problems could in any way be ignored. In a way (even within physical science), he ascribes a subjective, but highly objectified (through theories, models and so on) aspect to our dealing with reality, in the sense that the observer cannot totally exclude himself from the reality he investigates. "This naturally involves an interaction between himself [the observer] and not-himself, between observer and observed, and ultimately this means that he must use his physical senses" (Atkin, 1974c, p.82). Moreover, Atkin's conception of 'space' is quite opposed to taking space as something *absolute* or *a priori*.

"It is essentially a Newtonian *idea* (rather than an observation) that space is something *a priori*, a sort of thing *wherein objects are found*. We move around and have our being *in space*; we are not a structural part of that thing space. On the other hand it is essentially a Leibnitzian view that our idea of space is a concomitant of the relations between objects. In other words, Leibnitz sought for the meaning of the word 'space' in relations between observed sets (of objects) and not as an unobservable prerequisite for observed sets." (Atkin, 1974c, pp.82-3, his emphasis)

The difference between the two conceptions of space, says Atkin (p.83), is profound and turns out to be important in the form and content of *physical theories* about all phenomena set against a

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23. This is similar to the questions encountered by theories of taxonomy and pattern recognition. See Jardine and Sibson (1971) and Hubert (1974), for a discussion.

*backcloth* of the thing called 'space'. However, while these two conceptions may appear as opposed to each other, in fact, within an architectural context, each holds true at some conceptual level of consideration (see Chapter 4, Section 4.4).

### 3.6 CONCLUSIONS

In the light of the preceding survey, it can be argued that no specific comprehensive framework can be found within which research on the different aspects of space and its relation to architecture is coordinated and comparative studies might be implemented. Many investigators seem inclined to deal with space, and consequently the built environment, according to the disciplinary origin of the descriptors they employ, though attention is paid to evolving these within an architectural context. The result is an obvious disparity between the different formulations which cannot as yet claim a unifying theory or a conceptual structure through which they enrich the positive qualities of each other. Thus their collective import tends to be limited. In their own separate ways, they, of course, do have potential implications (ranging from the strong to the weak) for architectural design, but many of them are rather difficult to interpret easily at that level and most of the knowledge produced remains at a preoperational stage.

Nevertheless, though the discussion in this chapter has tended to be critical, it would be quite wrong to suggest that any of the present formulations is unimportant or not useful. As serious forms of analysis, they offer insight at various levels of consideration and each adds something valuable to our understanding. They capture an aspect of reality which would otherwise remain hidden. Some constructive concepts and well articulated descriptive tools have been evolved and related to architectural phenomena. These may usefully be adopted in the development of new theory. A constructive task for theory is to investigate how the different images, created by the descriptors it embodies, relate to the real 'identity' of environmental structures, and to the limitations and potential of design action. Important to this is not whether 'artificial space' or the built environment is *technically* describable in terms of a particular set of descriptors, but how comprehensive this set of descriptors is, what are the contradictions and anomalies *within* and *between* the different images it creates, and what is the operational status and problem-solving capacity of the knowledge produced.

What makes such a theory viable is that there seems to emerge from the different formulations a general awareness and interest in the concept of 'structure' as a tool for understanding. This awareness establishes a preliminary unifying link between the different approaches. This makes the role played by *structure* quite central to any new conceptualization. An important task, then, is to uncover the nature of the concept of structure and

broaden its scope.

The chapter that follows, Part II and Appendices I and II make a contribution in that direction, but closely related to questions of built environment. That is also where the syntagmatic framework will be discussed in some detail and extended in its application. The following chapter, however, continues to deal with aspects of space in order to elucidate the concept of 'architectural space'. Some new terminology which will be of benefit in later parts of this thesis is also introduced, while the general features that constitute what might be termed an 'architectural structure' are established in preliminary form.

## CHAPTER 4

### SPACE, ARCHITECTURE AND STRUCTURE

#### 4.1 INTRODUCTION

In the preceding chapter, it was shown that the multitude of approaches specially designed to deal with space in the built environment are varied in origin and orientation; none of them being separately sufficient, but each of them helping towards a better understanding. What they reveal is that, like other powerful concepts, 'space' is prolific with meaning and that at different times and in different architectural contexts one is dealing with different kinds of *spaces* whose congruence is an important issue in design. But how do notions of space generally arise? This chapter sets out to explore, in brief, some of the various ways spatial experience and fundamental conceptualizations of space are said to originate and to become differentiated. It draws initially on the contribution made by developmental theory (from a Cassirerian-Piagetian-Wernerian point of view), but elaborates the discussion progressively in order to involve evidence presented by many authors (including Harvey, Arnheim, Eisenman and Langer) who discuss the idea of space in relation to many fields (such as physical science, geography, anthropology and art), but most importantly attempt to define it in architectural terms. This yields a number of fundamental conceptual tools which when

combined with the ones already obtained in the preceding chapter, explain much of the underlying structure of <sup>the</sup> man-made environment.

This leads to a generalized definition of what constitutes 'artificial' or 'architectural space' as opposed to 'natural space' and what is the relationship between these two and between them and man - most significantly as a socio-cultural being. At this stage, the need for <sup>a</sup> structural approach becomes clear. The argument advanced (supported initially by a model of C.B. Wilson, but more elaborately by a much earlier one suggested by D. Foley) is that the proper investigation of questions of space involves issues other than the spatial and the physical (that is environmental). The extended involvement of aspects other than these two, however, automatically results in an increased logical complexity. To deal with the high level of logical complexity involved, a broader conceptual framework which covers the comprehensive description of built environment structures is necessary.

In their totality, built environmental structures have to be examined in relation to many aspects: their spatial and aspatial properties; their institutional (socio-cultural and normative), activity (functional) and environmental (physical) characteristics; and their characterization in terms of both stable forms, and dynamic and historical processes which transform them from one state to another at various times. The involvement of the historical dimension is important in that it is within historical contexts that the various systems of social evaluation (economic, aesthetic, political and so on) which are involved in the apprehension,



description and generation of these structures are originated. In investigating the kind of logical complexity of which these structures are constituted, a number of areas of concern emerge, the most important of which is: how are architectural design actions governed by the nature of the complexity of architectural structures themselves, on the one hand, and by the conceptual tools used in their understanding and description, on the other?

#### 4.2 SPATIAL EXPERIENCE AND COGNITIVE DEVELOPMENT

According to Harvey (1969, p.192) concepts of space are essentially founded in experience. In its most elementary form this experience is entirely visual and tactile. But as this experience develops, senses other than the visual and conceptualizations other than the concrete and physical get involved. Thus there is a transition from primary sensory experience of space to the development of intuitive spatial concepts and ultimately to the full formalization of such spatial concepts in terms of some geometric language (Cassirer, 1959, p.148). In the process of this transition, primary sensory experience, myth and image, cultural form and scientific concepts interact. As a result, it becomes extraordinarily difficult to determine how precisely concepts of space arise and how such concepts become sufficiently explicit for full formal representation to be possible (Harvey, 1969, p.192).

A comprehensive study of spatial experience and experiential

space would require the examination of sensory, perceived and conceptual spaces, noting how the more abstract ideas of space develop out of those given directly to the human body, both from the standpoint of man as an individual and from his perspective as a societal being. A detailed undertaking of this kind is beyond the scope of this thesis, but the potential and significance of the general conclusions reached by developmental theorists in helping the understanding of the nature of spatial experience in built environment contexts cannot be overestimated<sup>1</sup>.

In a structural-developmental sense, spatial experience reflects a progression from the concrete to the abstract and symbolic, and from the level of physical (sensorimotor) action in space, to perception of space, to conception and thought (at the level of pure ideas) about space. The term 'development' is obviously applicable to the description of a process changing over time, but the principle, as it has been evolved by its chief proponents (J. Piaget, and H. Werner; see Hart and Moore, 1973), defines development in terms of the *degree of organization* (that is the more differentiated and hierarchically integrated a system is, the more developed it is). Thus it is not limited to processes changing over time, but also may be used for the conceptual ordering of contemporaneous systems (Hart and Moore,

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1. *For a comparative review of developmental theories of spatial cognition, see Hart and Moore (1973). Besides reviewing the literature, they suggest a line of research consistent with the major theories of cognitive development (especially those of Piaget and Werner) which extends the investigation into the study of large-scale environments. See also Pocock and Hudson (1978, Chapter 4, in particular), for further discussion.*

1973, p.254). It is also accepted that while developmental processes may essentially be conceived as progressive, they are also subject to reversibility. Therefore, it seems more productive to try to understand *how* development takes place than exactly *when* it can be expected to occur.

Inherent in the developmental view of spatial experience are the qualitative changes in the structural organization of experience from one level to the other, and it is the description of the characteristic pattern of each of these levels and the explanation of relationships and transformations between them which has been most important to all theories of development. The philosopher E. Cassirer, during the course of his detailed analysis of the nature of human culture and the fundamental symbolic forms it takes, was one of the first to deal with space developmentally.

#### 4.2.1 Cassirer's Theory of Symbolic Forms and Spatial Experience

Following Kant, Cassirer called space and time the chief modes of experience: that is, "We cannot conceive of any real thing except under the condition of space and time" (Cassirer, 1944, p.42); and he treated the problems of both extensively. In terms of space, he provided a series of useful categorizations of the kinds of spatial experiences involved in man's conception of space. In *An Essay on Man* (Cassirer, 1944, pp.42-9; see also Harvey, 1973, p.23; Hart and Moore, 1973, pp.252-3), Cassirer differentiates between three primary categories of spatial experience;

*organic space, perceptual space and symbolic space.* Organic space (which man shares with all animals) refers to the kind of spatial experience which appears to be genetically transmitted and hence biologically determined. It is spatial experience of the lowest order - at the level of body presence in the world. The second order of spatial experience is perceptual space (which man shares with higher animals). It involves the integration of different kinds of sense experience - optical, tactile, acoustical, and so forth. This integration takes the form of schemata in which the evidence of the various senses is reconciled and coordinated. These schemata are also subject to qualitative changes by cognitive and culturally learned modes of thought. The highest order of spatial experience is symbolic space. Humans alone develop the ability to comprehend and represent the idea of abstract space - the space of pure intuition dispossessed of any necessary concrete referent. Symbolic space refers to abstract and contemplative experience, where space is experienced through the interpretation of symbolic representations which have no spatial dimensions in themselves - though they refer to such dimensions. For instance, geometry provides a convenient symbolic language for discussing and learning about spatial form, but it is not the spatial form itself - its points and lines are neither physical nor psychological objects; they are nothing but symbols for abstract relations.

"Geometrical space abstracts from all the variety and heterogeneity imposed upon us by the disparate nature of our senses. Here we have a homogeneous, a universal space. And it was only by the medium of this new and characteristic form of space that man could arrive at the concept of a unique, systematic *cosmic* order. The idea of such an order, of the unity and the lawfulness of the universe, never could have been reached without the idea of a uniform space."  
(Cassirer, 1944, p.45, his emphasis).

Furthermore, there is an important distinction between concrete acquaintance with, and abstract knowledge of, space and spatial relations.

"Acquaintance means only presentation; knowledge includes and presupposes representation. The representation of an object is quite a different act from the mere handling of the object. The latter demands nothing but a definite series of actions.... It is a matter of habit acquired by a constantly repeated unvarying performance of certain acts. But the representation of space and spatial relations means much more. To represent a thing is not enough to be able to manipulate it in the right way and for practical uses. We must have a general conception of the object, and regard it from different angles in order to find its relations to other objects. We must locate it and determine its position in a general system."  
(Cassirer, 1944, p.46)

#### 4.2.2 Psychological Theory of Development of Notions of Space and the Epistemological Contribution of Piaget

In the psychological field, both Piaget and Werner (the two highly influential theorists of developmental psychology) develop similar views to Cassirer, but in a more elaborate and empirically-based fashion. In their general theories, they share the idea (summarized in Pocock and Hudson, 1978, p.89) that development can

be seen as a process involving the increasing differentiation of child and environment, followed by a reintegration between self and environment. That is, it is a progression from a state of relative globality and lack of differentiation to states of increasing differentiation, articulation and hierarchic integration. Piaget, in particular, offers a powerful theory which has been extended from a mere psychological programme into an epistemological one in the shape of his so-called *genetic epistemology* (Piaget, 1971; 1972; Hart and Moore, 1973) with its strong concern over the acquisition and development of human knowledge<sup>2</sup>.

Parallel to his general theory of cognitive development (and later *genetic epistemology*), Piaget's 'specific' theory of development of conceptions of space offers several important conclusions. First, conception of space arises from the coordination and internalization of actions: that is knowledge of space is a function of action rather than mere perception. Related to this, the genesis of images of space arises from the internalization of deferred imitations: initially, the child copies other people's action, but later these become remembered and so available when appropriate at a later time. A third point is that there are four levels (or structure) of spatial organization corresponding to four major hierarchic and successive phases of development (sensorimotor → preoperational → concrete operational → formal

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2. *Further details of Piaget's theory of genetic epistemology can be followed in the cited literature and many of his other numerous publications (for instance, Piaget, 1973).*

operational). Finally, there are three classes of specific spatial relations which develop first; projective; projective; metric or Euclidean.

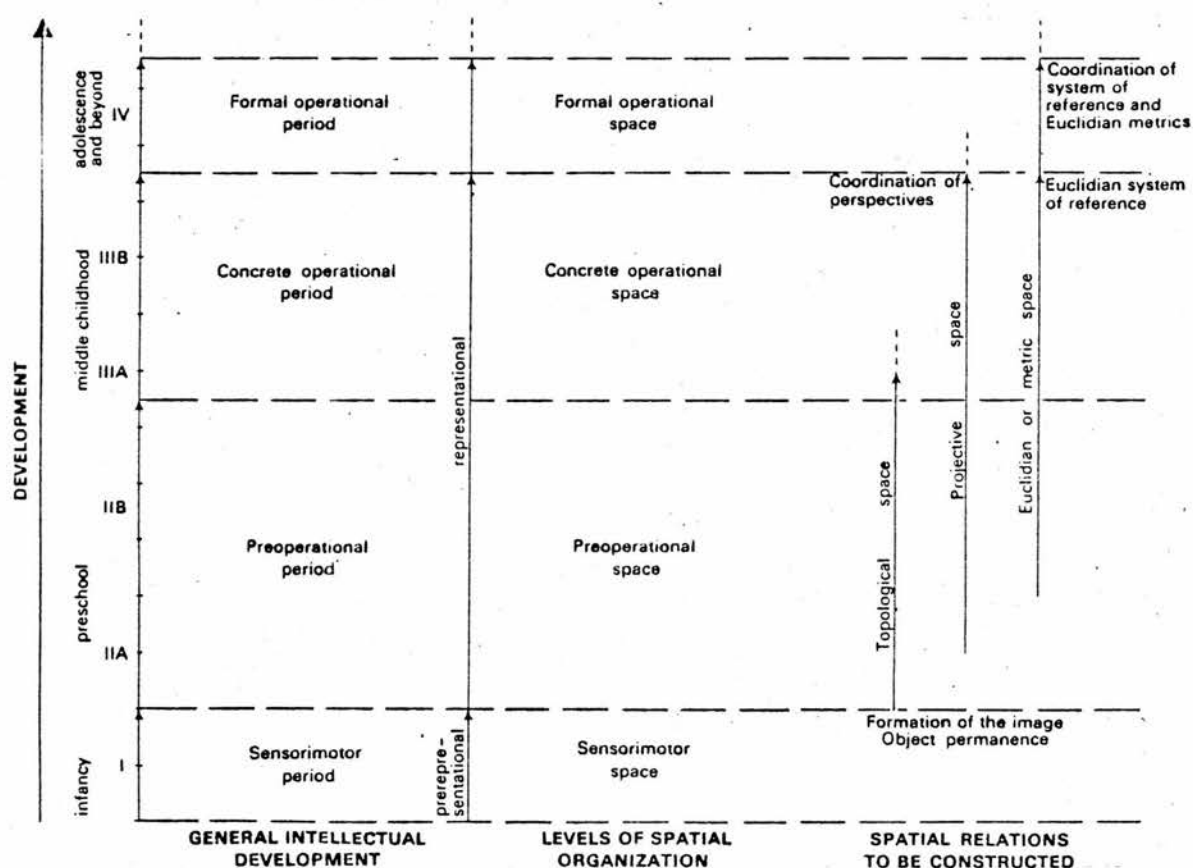


Fig. 4.1 Schematic representation of Piaget's theory of the development of spatial cognition in relation to overall intellectual development. (From Hart and Moore, 1973, p.265)



However, the most important contribution the developmental model of spatial cognition makes (most significantly in its generalized Piagetian epistemological form) is that it avoids the difficulties of both the *rationalist* concept of innate ideas and the *empiricist* alternative of environmental determinism. Piaget (1971; 1972; see also Gablik, 1976, p.73), for instance, completely rejects any *a priorist* position which asserts that space (or time or causality) is a category of mind with permanent structure and processes, instead he believes that our way of representing the world is regulated by cognitive processes of different degrees of development. On the other hand, our spatial notions do not derive directly from perception of the environment, but imply a logical construction and stages of formation. Thus the *intuition* of space is not an innocent reading or apprehension of the properties of environmental objects, but from the very beginning is an action (mainly in terms of operational thinking) performed on them. The physical order found in the object is not a directly abstracted quality, but is reproduced in a process of increasing coordinated actions, so that a whole series of *virtual relationships* will be brought into play which go beyond the data recorded by pure sense-perception.

This is why the act of representation (which implies the use of imaginary concepts) is usually richer than pure perception, precisely because it incorporates knowledge of the object's possible transformations. The ability to represent an object transcends its perception, since its image is not a simple copy, but comprises an element of mental reconstitution. It is only by understanding the



structural transformation of a phenomenon that we are able to fully understand and scientifically explain its mature form.

"Were it not for the idea of transformation, structures would lose all explanatory import, since they would collapse into static forms."  
(Piaget, 1971, p.12).

Representation, then, presumes internal mental activity over and above perception. At the representational level, the emergence of spatial concepts is inextricably bound up with the structure of the culture in which such concepts are being developed.

#### 4.3 SOCIO-CULTURAL AND PHYSICAL SPACE

##### 4.3.1 Socio-cultural Space

The decisive role played by culture in the development of spatial concepts is supported by a huge body of anthropological evidence.

"Anthropological studies have indicated considerable variation in the nature of spatial concepts from one society to another. This is scarcely surprising since the representation of space 'involves the evocation of objects in their absence' (Piaget, 1956, 17). It involves relating imagined concepts to other concepts and further it also involves concepts which have no empirical content - in particular it involves concepts such as 'empty space', 'infinity' and so on. The emergence of concepts of this kind is partly governed by language and partly by culture (Kluckhohn, 1954) ....

Concepts of space thus vary from one cultural context

to another, and within broad cultural configurations smaller sub-groups may develop a particular conceptual apparatus with respect to space geared to the particular role which they perform in society." (Harvey, 1969, p.194).

Moreover,

"The conceptual framework which a society develops to represent space is not, however, static. Spatial concepts have changed very substantially since antiquity. Cultural change often involves change in spatial concepts, but on occasion the sudden need to reappraise spatial concepts through scientific discovery has delivered a powerful jolt to an existing set of cultural values." (Harvey, 1969, p.194).

In *Social Justice and the City*, Harvey (1973, pp.28-31) develops this discussion much further. Accepting the three levels of spatial experience (the organic, the perceptual and the symbolic) identified by Cassirer, he emphasizes the problems that arise in the process of transferring experience gained at one level to a mode of experience operating at another level. The difficulties involved in studying the interactions or transformations between these modes of spatial experience is not so much that any of these modes is in itself not structured, but more that there are no obvious *isomorphisms* among them which would automatically lead to a successful (or one to one) mapping between one mode of experience to another. Furthermore, while it might be quite convenient to argue that the actual physical space which people experience and perceive is not far from being Euclidean and, therefore, may best be describable in Euclidean terms, there is no clear evidence that the social activities which take place in this physical space are

in any way structurally Euclidean.

"Each form of social activity defines its space; there is no evidence that such spaces are Euclidean or even that they are remotely similar to each other.... A primary need, if we are to understand the spatial form of the [built-environment], therefore, is the articulation of an adequate philosophy of social space."

(Harvey, 1973, p.30).

Spatial experience is, therefore, predominantly social, in the sense that particular spatial experiences are embedded in some wider socio-cultural experience and it is through socio-cultural value systems that hierarchies between the various spatial experiences are structured.

"In other words, the shaping of space which goes on in architecture and, therefore, in the city is symbolic of our culture, symbolic of the existing social order, symbolic of our aspirations, our needs, and our fears. If, therefore, we are to evaluate the spatial form of the city, we must, somehow or other, understand its creative meaning as well as its mere physical dimensions."

(Harvey, 1973, p.31).

#### 4.3.2 Physical Space

Implicit in the argument developed so far is a strong rejection of any physical determinism. But to reject physical determinism as an absolute base for describing or generating built environment is neither to impose a socio-cultural determinism nor to argue against the idea of effectively studying built environment from a physical point of view. Indeed, the most obvious result of architectural activity is built form. And built forms as buildings

or man-made environmental objects are undoubtedly physical and belong to a physical system.

"The system carries information which is capable of interpretation by people in different ways, but the information is physical in origin and physical in transmission. Moreover, the architect specifies only physical characteristics. However he may think about his building, his design is a set of instructions for a particular arrangement of pieces of material."  
(Wilson, 1973a, p.413).

Therefore, the consideration of space in physical terms is very important and has always provided a convenient start for environmental theories of space. This is understandable, since it is the physical attributes of space which are the most intuitive reason why space is artificially differentiated and experienced. Physical considerations have also been aided by the availability of highly developed formal languages much of the historical and conceptual evolution of which has been closely linked with the development of physical science - with its special interest in space as a physical phenomenon. This combined history is, of course, a comparatively long one and involves numerous philosophical and scientific contributions. Consequently, there have been variations in the details of the space concepts that have been originated, but these are essentially founded on two contrasting views (Jammer, 1954; Harvey, 1969; Arnheim, 1977; Davies, 1977; Atkin, 1974c).

The first presents space as *infinite, homogeneous* and *a priori*; a container of all material entities existing prior to and

independently of, the physical bodies that find their place in it. It is an *absolute* framework unchanged by the behaviour of its contents. It is the space of Newtonian physics, the geometry of Euclid and the Cartesian coordinate system. The second view is the view advanced by Leibniz which culminated, through a series of mathematical developments and the construction of several non-Euclidean geometries during the nineteenth century, in the Theory of Relativity and the development of modern physics. It sees space as a positional quality of the world of material objects or events. It is both *relative* and *relational*. It presents space as a relationship *between* objects which exists only because objects exist and relate to each other; and as contained *within* objects in the sense that an object can be said to exist only in so far as it contains and represents within itself relationships to other objects (Harvey, 1973, p.13).

The rationale behind this relationist view is based on the fact that the acquisition of information about physical or actual space depends upon measurements and observations carried out using material objects, light signals and so on (Davies, 1977, p.2). The objects themselves maintain their relative existence in four-dimensional *space-time*.

The difference between these two views of space has, of course, been of fundamental consequence in the form and content of physical theories. Obviously, philosophical and scientific debates about the ultimate nature of physical or actual space are likely to continue, including disputes perhaps on its dimension-

ality or the kind of geometries most useful in its description and representation. But, although the various theories advanced may be presented as reinforcing, conflicting with or superior to, each other, the essential point is that neither of the two major views above necessarily implies the total elimination of the other from the conceptual scheme of physical science.

"It is, in fact, rather rare (in physical science at least) that a fully accepted theory is actually *wrong* in the strict sense of the word. Newtonian mechanics, and the associated model of space and time, served well for 200 years and more, and continue to serve well today. Newton was not wrong. The fact that his theory has been superseded by the theories of relativity and quantum mechanics means that the limits of validity of Newton's theory are now known. Both relativity and quantum mechanics *contain* Newtonian mechanics at the level of an approximation, which is an exceedingly good one in everyday affairs of the world. Nobody would dream of using general relativity to compute the path of an aeroplane."  
(Davies, 1977, p.200-1, his emphasis).

Therefore,

"It may be realistic to regard the concept of space as a 'multidimensional' concept in the sense that the concept has a different meaning according to cultural background, perceptual ability and scientific purpose."  
(Harvey, 1969, p.197).

#### 4.4 ARCHITECTURAL SPACE AND NATURAL SPACE

From an architectural point of view, it is interesting to observe that each of the above views on space holds true at some important level of consideration (Arnheim, 1977, pp.9-10). On

the one hand, without taking space as the minimum 'given' that precedes the objects in it (the setting in which everything takes place), it is quite difficult to apprehend the nature of architecture as an act of space differentiation<sup>3</sup> and heterogenization (through *barrierization*); an act of arrangement of built-environment artefacts placed within a supposedly given, homogeneous and continuous space. Built environment artefacts exist in space, however, without destroying completely the idea of a continuous volume of space enveloping them.

On the other hand, this conception of space cannot describe adequately the way the cognition of space comes about psychologically. That is, although space - once established - is experienced as an always present and self-evident given, everyday experience of space is generated, through the interrelation of objects within some sort of definable fields (Arnheim, 1977, p.10). This implies *channelization* (the establishment of networks or channels of connectivity). Even with a single building, this is what goes on between its inside and outside<sup>4</sup>.

"It is quite in accordance with the fundamental function of architecture that neither a complete separation of inside and outside nor a complete integration of both can ever be achieved. No work of architecture is totally closed against the outside, but neither can it ultimately conceal its function of separation. As much

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3. In general terms, differentiation may be applied to both physical phenomena and abstract concepts, and it represents the real or imaginary existence of a physical or an abstract barrier (boundary or demarcation), respectively. In either case, the existence of a barrier (or boundary) can be seen in terms of two important and logically different ways: (i) positive, by distinguishing between things through similar attributes, but at different qualitative or quantitative scales; (ii) negative, by distinguishing between things through dissimilar attributes (that is presence or absence of properties).
  4. The relationship between inside and outside has been, of course, a favourite theme in architectural theories of aesthetics. It

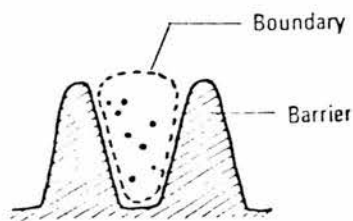


as every inside tries to protect itself against intrusion, it can never deny the existence of the outside.... On the other hand, no inside can ever totally fuse with the outside. If such amalgamation were possible, it would mean that an artificial creation of man had sunk back into the undifferentiated matrix of nature from which it was once cut out." (Zucker, 1966, p.11).

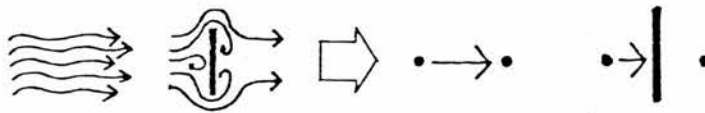
Put another way, the main aim of architecture is to mediate between man and the undifferentiated consistency of his immediate natural environment as it exists. Its basic tool for doing this is the use of barriers (which ultimately generate boundaries) in order to create enclosures. But the extremity of complete enclosures is counterbalanced by introducing channels (or making the barriers permeable), since the aim is not a total differentiation or exclusion from other differentiated domains or the rest of nature. Thus, though the most primitive architectural gesture may be a barrier or boundary gesture, in its most elementary operational form an architectural structure is a *dual structure* of barrier/channel character<sup>5</sup>; barrier in order to heterogenize a homogeneous surrounding natural environment and a channel in order to partially homogenize or access an artificially heterogenized one.

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4. (contd) still constitutes some popular approaches to architecture such as that of Venturi (1966).
  5. In Appendix I, it is shown that this operational barrier/channel structure can be elaborated syntactically in order to describe the built environment from the level of a room (cell or enclosure) to the level of a whole settlement (cf. the 'space syntax' model of Hillier et al, 1976). However, it has been observed that the history of architecture does not signify a very strong change in the way that elementary barrierization is worked out (although the development of frame-structures and so on has given much freedom to making variation in this), but it signifies a remarkable change in the way this operation is socially evaluated. As opposed to this, the historical evolution of channelization does show not only a differentiation in the social evaluation of networks, but also important changes in the physical properties, the identities and complexity of them (see Appendix I, Section 3).





Elementary barrierization



Elementary channelization

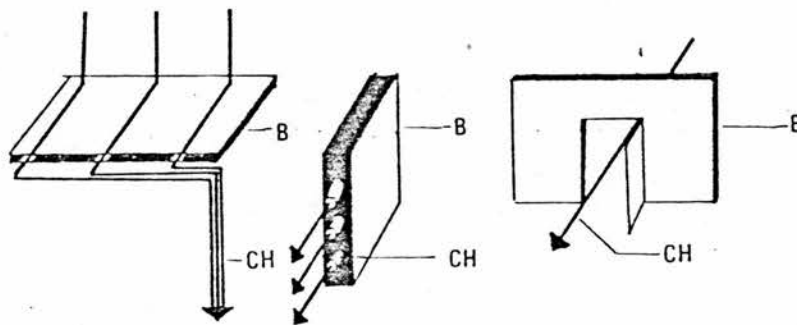
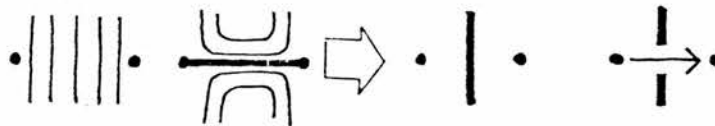


Fig. 4.2 Dual identity of elementary architectural operations (see Appendix I, pp. 309-10)

In fact, this dual structure is embedded even in what might at first sight seem to be a pure barrier phenomenon: for instance, a

solid wall. A solid wall is a barrier to human circulation, but this same wall is a channel for transmitting loads. In terms of heat, any barrier is actually penetrable. Therefore, the act of introducing a barrier is quite complex. This complexity is reflected by the number of boundaries a barrier creates. It is obvious that there will be as many boundaries as there are domains and there are many domains as there are specifiable fields. And since the environment is multidimensional (if only climatically), these boundaries are in different places for different reasons and purposes<sup>6</sup> (McCleary, 1972, p.108).

More importantly, space can also be interpreted in terms of the two categories of 'natural (or universal) space' and that of 'artificial space' (which within the context of this thesis is taken at the level of the built environment and, therefore, will be called 'architectural space', most commonly). Any man-made environment presupposes a natural environment for which it is a modification. Thus in its general form, *natural space* is the space of the total natural environment - but linked to earth-bound phenomena. In global terms, it exists irrespective of the history or location of human settlements in it. It is differentiated on purely geophysical terms (climate, vegetation, topography and so on), and outside specific localities, the ecological argument

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6. Refer to Appendix I, Sections 3 and 4, for further discussion.

notwithstanding<sup>7</sup>, it is treated as universal and different from artificial space.

*Artificial or architectural space* refers simply to that component of natural space which is defined or modified by a variety of human architectural actions for the purpose of habitation and settlement. (This definition, obviously, excludes the political definition of regions, countries and the like). In its most obvious way, it is recognized through the intuitive recognition of architectural objects. It holds quite different meanings for man.

"Physical convenience rather than necessity was the early reason for the creation of 'architectural space' in general, and was the motivation for moving life from the 'universal space' that man shared with animals to 'architectural space'. Due to the ever increasing psychological sensitivity of man toward environment and his diminishing physical ability to resist climatic extremes, 'architectural space' has long since become a prerequisite for human existence." (Engel, 1965, p.246).

Architectural space, since it is capable of creating micro-environments suited to the most various functions of man's social and physical life, may justly be described as representing the aim of architecture. It is architecturally organized space. To this effect, the significance of *tectonics* as an organizing feature is evident by definition (Markuzon, 1972, p.42). Without the

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7. *In the present circumstances of overpopulation, pollution and so on, the case for the ecological argument is, of course, overwhelming. It is argued that even the natural environment is no longer what it is, it is in the process of being man-created (Lefebvre, 1976, pp.32-3). However, without in any way disputing the case for this argument, the interest here is in man-made environment which has been produced for the purpose of human habitation and settlement and persists most obviously in the form of built forms, comprising so-called built environment.*

architectural hardware, the material fabric and the erection of *building* (extending from tent to pyramid and from wall or fence to complete enclosure), there can be no architectural space. This applies just as fully to the streets and open spaces which have been bounded out of their natural environment by volumes of surrounding buildings as to those inside spaces enclosed within them. The involvement of the 'architectural body', that is building in its morphological/physical nature, leads to peculiar properties. A basic one is what might be called accumulation of products on land.

"The built environment functions quite frequently as a commodity for consumption, but at the same time it is also based on land; it remains for a longer period than the capacity of the construction industry would imply and transfers the characteristics of its production process from one historical moment to the other by transforming its semantic and pragmatic value. The built environment signifies, furthermore, the successiveness of the material substances of the ideologies which have been dominating its production and it is, also, one of the best preserved signifier of them."

(Kotsiopoulos, 1978, p.52-3).

Despite the determinate involvement of an undoubtedly physical body like building in defining architectural space, architectural space has an equally strong 'virtual'<sup>8</sup> nature (borrowing the term from Langer, 1953). While the dialectic potential of actual and virtual exists in all physical phenomena, its manifestation in

- 
8. *'Virtual space' is conceptual and non-physical in inception, but can be given manifest form or structure through objects. A similar concept to it is perhaps Hillier and Leaman's (1973b, p.510) idea of 'logical space'. "Logical space is an imaginary, many dimensional space created by and filled with signs, symbols and representations. It exists neither purely in our heads, nor in real space outside, but constitutes the medium through which the relation between the two is made. It works both ways. Logical space creates spatial or architectural space as one of a number of perceptual 'realities' it interprets. It represents the results of our cognitive operations on the world, including the world of artificial things."*

architecture is held to be special.

#### 4.5 ARCHITECTURAL SPACE AND VIRTUAL SPACE

P. Eisenman, throughout his work, has been mainly syntactic orientated, and he draws a useful comparison between the virtual nature of architectural space, on the one hand, and pictorial and sculptural space on the other. In both painting and sculpture, argues Eisenman (1973, p.323), there is an inherent dialectic between observer and space which is not initially present in architecture. That is whatever real space there is in painting and sculpture, the observer is usually outside of it; his relationship to that space can be considered *virtual* rather than *actual*. Thus any understanding he has of that space, whether perceptual or mental will always be in a sense conceptual in that he can never experience the actual space.

But we can have our physical being in architecture and involve all our senses. Our relationship to it is initially *actual* and our experience of space to that extent *real*. But, continues Eisenman, if one posits that all physical reality has inherent in it a capacity for an opposite or virtual state, because of the capacity of certain physical relationships to present a potential continuum from actual to virtual, then somehow we must seriously take this factor into account in any model concerned with the generation of architectural space.

"It is precisely because the individual has the capacity not only to perceive and actually walk through the space but to conceive of that space he will receive information which he will translate into conceptions. Therefore, if an architecture can make one more aware of the actual space ... potentially available in it, then this awareness might be made possible by the presence of an intentional virtual structure. In other words, since there is always the possibility in architecture of a virtual experience as well as a real experience, they both might be predetermined. However, in architecture as opposed to other plastic arts this virtual condition must be built into architectural space; it does not exist a priori. While those qualities remain latent in any environment, they must be modelled in both a surface and deep structural description."  
(Eisenman, 1973, p.323).

The comparison between pictorial, sculptural and architectural space which Eisenman draws had, of course, been long preceded by the one made by Langer (1953, especially Chapters 5 and 6). Langer takes architecture as one of the plastic arts. She argues that each of the plastic arts (as manifestations of spatial conception) has its own manifestation of virtual space which comes in increasing order of complexity starting with pictorial space, then sculptural space and finally architectural space.

First,

"... organized space in a picture is not experiential space, ... It is an entirely visual affair; for touch and hearing and muscular action it does not exist .... This purely visual space is an illusion, for our sensory experiences do not agree on it in their report. Pictorial space is not only organized by means of color ..., it is created; without the organizing shapes it is simply not there. Like the space 'behind' the surface of a mirror, it is what the physicists call 'virtual space' - an intangible image."  
(Langer, p.72)

Second,

"Sculpture creates an equally visual space, but not a space of direct vision; for volume is really given originally to touch, both haptic touch and contact limiting bodily movement, and the business of sculpture is to translate its data into entirely visual terms, i.e. *to make tactual space visible*." (Langer, pp.89-90, her emphasis).

But architecture, argues Langer, clearly has actual function, and it also defines and arranges spatial units in terms of actual spatial relationships which have meanings for us in terms of the space in which we live and move. Nevertheless, the architect deals with a *created space*, a virtual entity effected by a basic abstraction peculiar to architecture. This basic abstraction is described by Langer (p.95) as that of an 'ethnic domain'. Unlike painting and sculpture, architecture articulates the ethnic domain, or virtual space by treatment of an *actual place*.

The *ethnic domain* that goes with architecture is an entire functional realm made visible and tangible. It is the embodiment of the life of a culture,

"a physically present human environment that expresses the characteristic rhythmic functional patterns which constitute a culture." (Langer, p.96).

And,

"A universe created by man and for man, 'in the image of nature' - not, indeed, by simulating natural objects, but by exemplifying 'the laws of gravity, of statics and dynamics' - is the spatial *semblance* of a world, because it is made in actual space, yet is not systematically continuous with the rest of nature in a complete democracy of places. It has its

own center and periphery, not dividing one place from all others, but limiting from within whatever is to be. That is the image of an ethnic domain, the primary illusion of architecture."  
(p.97, her emphasis).

Thus as a product of human actions and a provision of a place in which human life and activities are to be comfortably supported, architectural space requires a much broader conceptual framework than the one sufficient to describe pure physical objects. In this framework, the total structure of architectural space becomes complicated. It has a natural component, a tectonic component and a human component. In its totality, it exists only through the interaction of these components *between* themselves and *within* themselves.

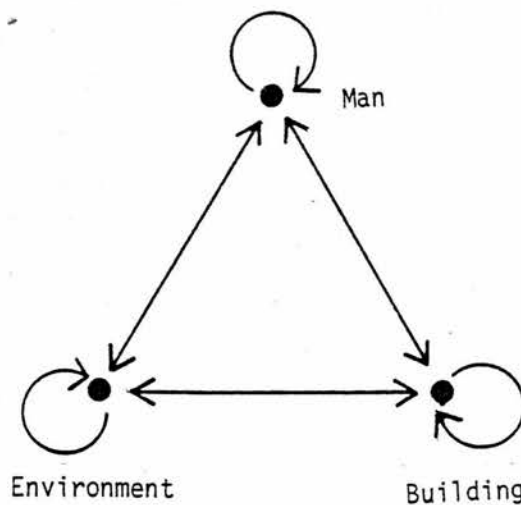


Fig. 4.3 Total structure of architectural space



From this, it is obvious that neither building nor the architectural space it defines remain purely physical. In fact, there is no need any longer to maintain a sharp conceptual or even practical distinction between architectural space and architecture in its wider sense. It is precisely *that which constitutes architectural space constitutes architecture*. Space has become the 'historically' constituted subject-matter of architecture (see Chapter 2).

#### 4.6 ARCHITECTURE AND STRUCTURE

C.B. Wilson (1973a) has recognized the totality of architectural structure and sought to formulate a mathematical model expressing the basic interrelationships involved in this total structure - but with emphasis on dealing with those which are physical. Wilson's model is expressed in terms of three relations:

$$E_1 = B \cdot (E_0) \quad . . . . \quad (1)$$

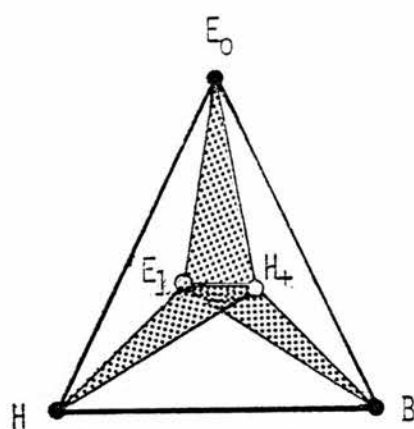
$$E_1 \cdot (H): H \rightarrow H_+ \quad . . . . \quad (2)$$

$$E_1 \cdot (B): B \rightarrow B \quad . . . . \quad (3)$$

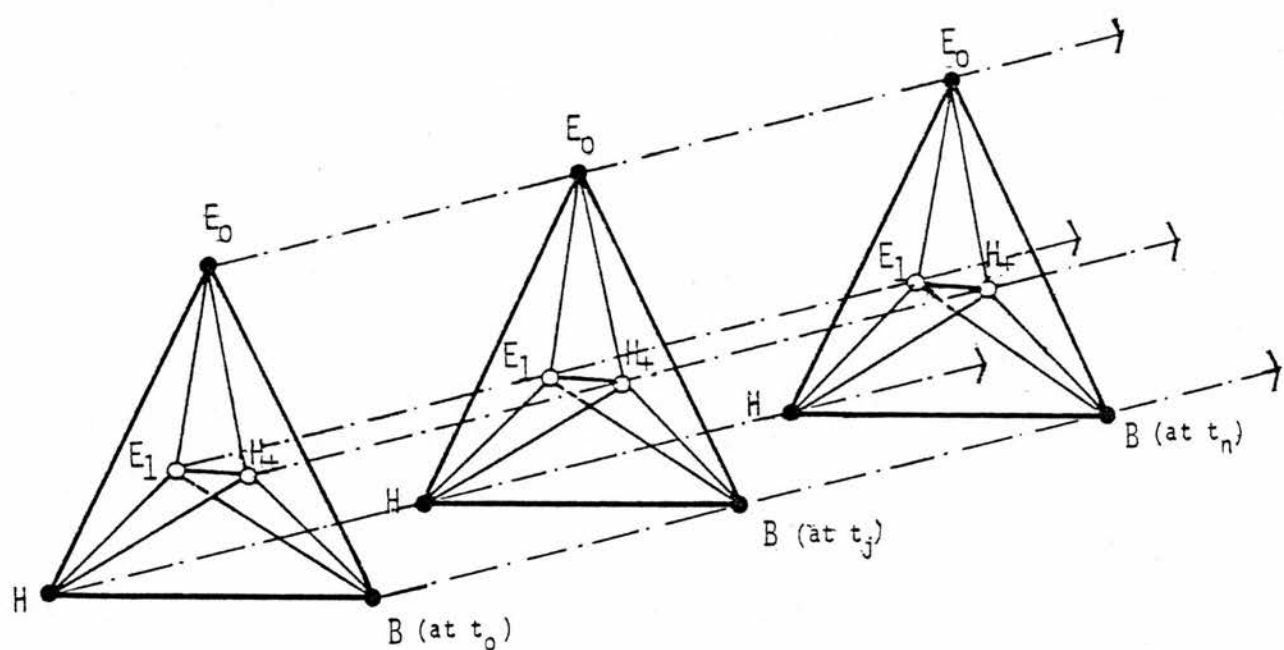
Where, H is human being;  $H_+$  is human being in a state of content where he does not require the transformation of the environment (E) from state  $E_0$  (environment before the existence of building (B)) to state  $E_1$  (the environment after the existence of building). The model is to be understood as cybernetic in the sense that, H

being in the state  $H_-$  (state of discontent and wish to change the environment) for  $E_0 \cdot (H)$ , a building is created. If this still leaves  $H$  in  $H_-$  a further attempt is made and so on. The relation expressed in (3) is a survival requirement in that the building must be unchanged by its environment (that is to withstand its action on building fabric structurally), though it is possible to introduce any acceptable deviation from an initial state of  $B$  and a finite life for  $B$  (see Fig. 4.4, for further elaboration).

The most important principle underlying Wilson's model is that architectural structure constitutes a totality, the appropriate consideration of which can only be achieved by taking the above listed relationships *simultaneously* into account. The ultimate aim, in Wilson's view (p.416) is, of course, to produce satisfactory building. Thus, "treated as equations (1), (2) and (3) are to be solved for  $B$ . That is the analogue, in the model, of the architect's task.". Wilson has developed the model further in order to deal with the physical relationships (especially climatic ones, these being more readily describable) in architecture that are expressed in (1) and (3), but he points out that the kind of solution reached for  $B$  and the means for approaching it will depend largely on assumptions which are made about  $H$  and  $E \cdot (H)$ . This calls for more effective descriptors whose nature is mainly socio-cultural, economic, psychological and so on.



Relations implied by  
Wilson's model



Wilson's model when a time dimension ( $t$ )  
is introduced, say, a building life-span

Fig. 4.4 Wilson's model expressed and  
elaborated graphically

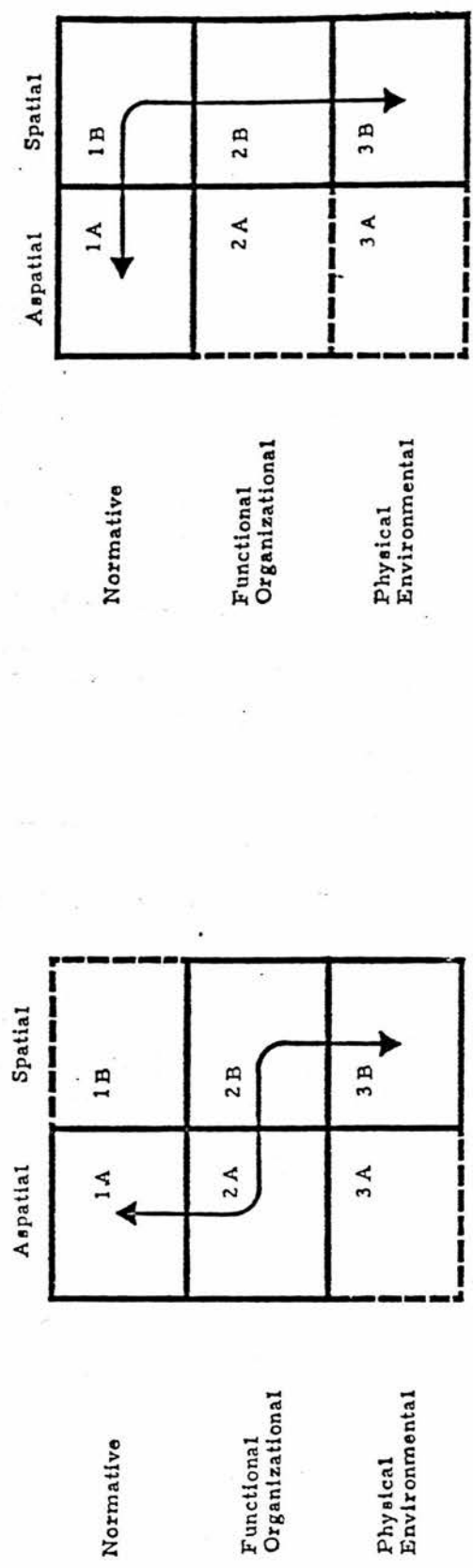
In a design context, one way for physical structure to come about is by a process of *translation* from other non-physical structures pre-existing in society, structures whose nature is the concern of the social sciences, economics, politics and so on (Atkin, 1974a, p.52). Foley (1964; see also Atkin, 1974a, for discussion and mathematical development) has been concerned with developing a general framework of 'metropolitan structure' and identifying within this framework the various interrelated steps involved in proceeding from abstract normative socio-cultural structures to the physical spatial ones through the functional organizational structures. He defines two important categories under which these structures may be further classified; 'spatial' and 'aspatial'.

*Spatial* refers to a direct concern for spatial pattern, that is for the pattern in which culture, institutions, activities, people and physical objects are distributed in space. *Aspatial* interrelationships of selected phenomena viewed within other frames of reference (such as political, social, economic and so on), but without special concern for their spatial distribution or arrangement.

On the basis of his conceptual scheme, Foley identifies various sets of relationships (see Fig. 4.5, but Fig. 4.6 for a more comprehensive representation) which could be investigated, but lays the greatest emphasis on the functional (activity) organizational level as the one that mediates between the aspatial/normative (institutional) structure and the spatial/

|                                     | A Aspatial Aspects  | B Spatial Aspects  |
|-------------------------------------|---|--|
| 1 Normative or Cultural Aspects     | 1A<br>Social values; culture patterns; norms; institutional setting; technology   | 1B<br>Spatial distribution of culture patterns and norms; values and norms directly concerned with the qualities and determination of the spatial patterns of activities, population, and the physical environment.    |
| 2 Functional Organizational Aspects | 2A<br>Division and allocation of functions; functional interdependence; activity systems and sub-systems, including persons and establishments in their functional-role sense | 2B<br>Spatial distribution of functions and activities; linkages (functional relations spatially conceived); spatial pattern of establishments, by functional type   |
| 3 Physical Aspects                  | 3A<br>Physical objects; the geophysical environment, man-developed material improvements, people as physical bodies; qualities of these objects                               | 3B<br>Spatial distribution of physical objects; the resulting spatial pattern formed by this distribution of land forms, buildings, roads, people, etc; distribution in space of varying qualities of physical objects |

Fig. 4.4 Selected aspects of metropolitan structure: a conceptual view. (After Foley, 1964, p.24)



(4,5,1) The main relationship, with functional organization (2A and 2B) as pivotal

(4,5,3) An alternative relationship: primary concern for values as to spatial arrangement (1B)



(4,5,2) An alternative relationship: primary concern for immediate physical environment (3A)

(4,5,4) An alternative direct relationship between values (1A via 1B) and the physical environment (3B)

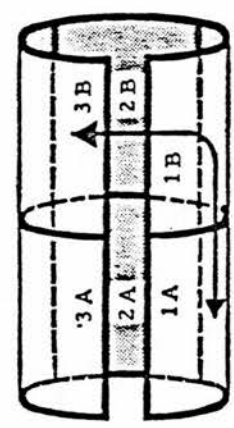


Diagram is rolled around so that the physical environment is placed next to the normative level. (The functional level is still in, but remains in the background.)

Fig. 4.5 Various relationships within metropolitan structure. (According to Foley, 1964, pp.30-1)

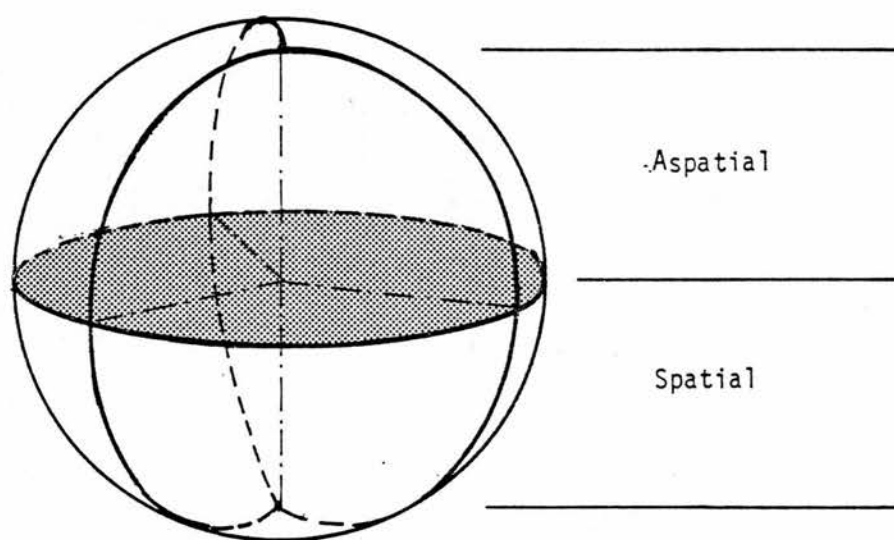
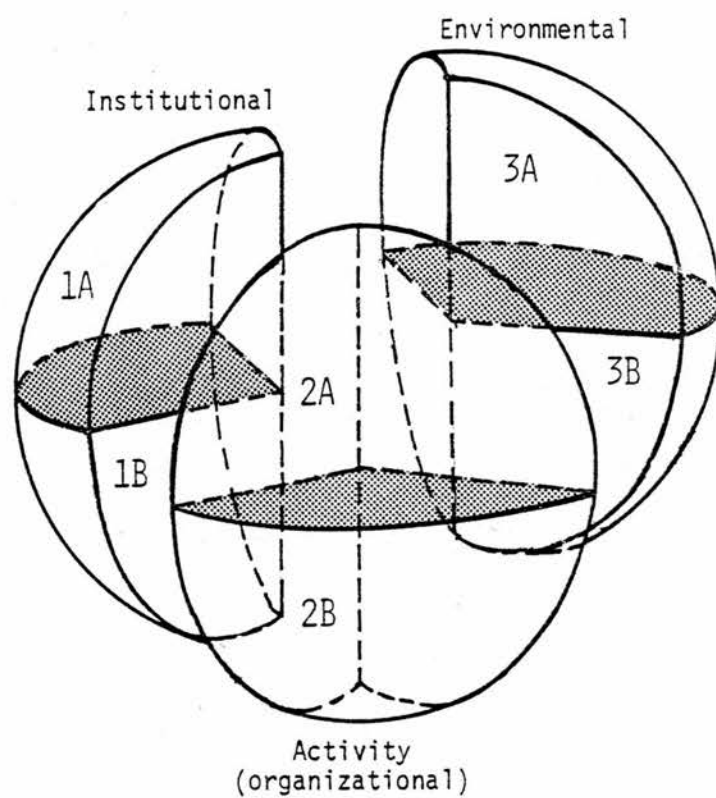


Fig. 4.6 An alternative representation of Foley's model

physical (environmental) one (Fig. 4.5.1).

"The key question is how to examine the implications of alternative spatial arrangements on the functioning of given units of social organization."  
(Foley, 1964, p.29)

Nevertheless, Foley's conception of structure is general in character and involves 'processual' (dynamic) considerations, besides purely 'morphological' (static) ones (see Fig. 4.7).

"We conceive of metropolitan structure as comprising both *formal* aspects - a static, snapshot view of the metropolitan community's pattern at any one point in time - and *processual* aspects - the ongoing functional relations of the metropolitan community. In such a view, the functioning of the community exhibits a pattern just as does the strictly morphological aspect of the community. With this conception, then, form and process may be readily treated as two complementary versions of structure."  
(Foley, p.35, his emphasis)

This maintains the same primary distinctions between aspatial and spatial, and carries forward the three levels of consideration (institutional, functional, environmental) previously identified. For each cell of the previous framework, there are added counterpart aspects of form and process. From this, various chains of reasoning and levels of structural complexity can be identified<sup>9</sup>. To this framework, a historical dimension is added (Fig. 4.8) - structure not only exists at a given moment in time and is in process within a given short period of time, but also evolves over time.

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9. See Foley (1964) for further details.



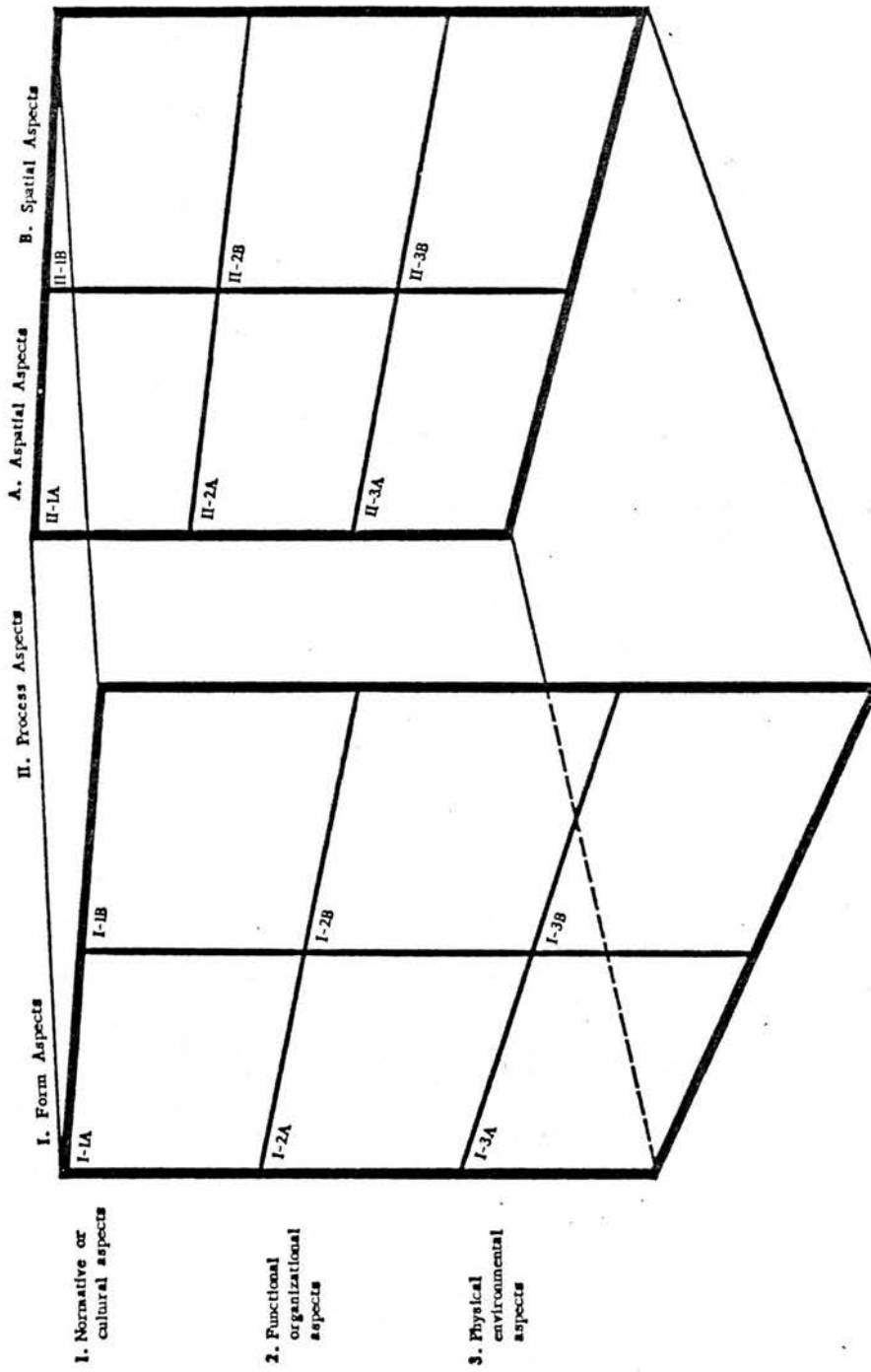


Fig. 4.7 Structural form and process.  
(According to Foley, p.36)

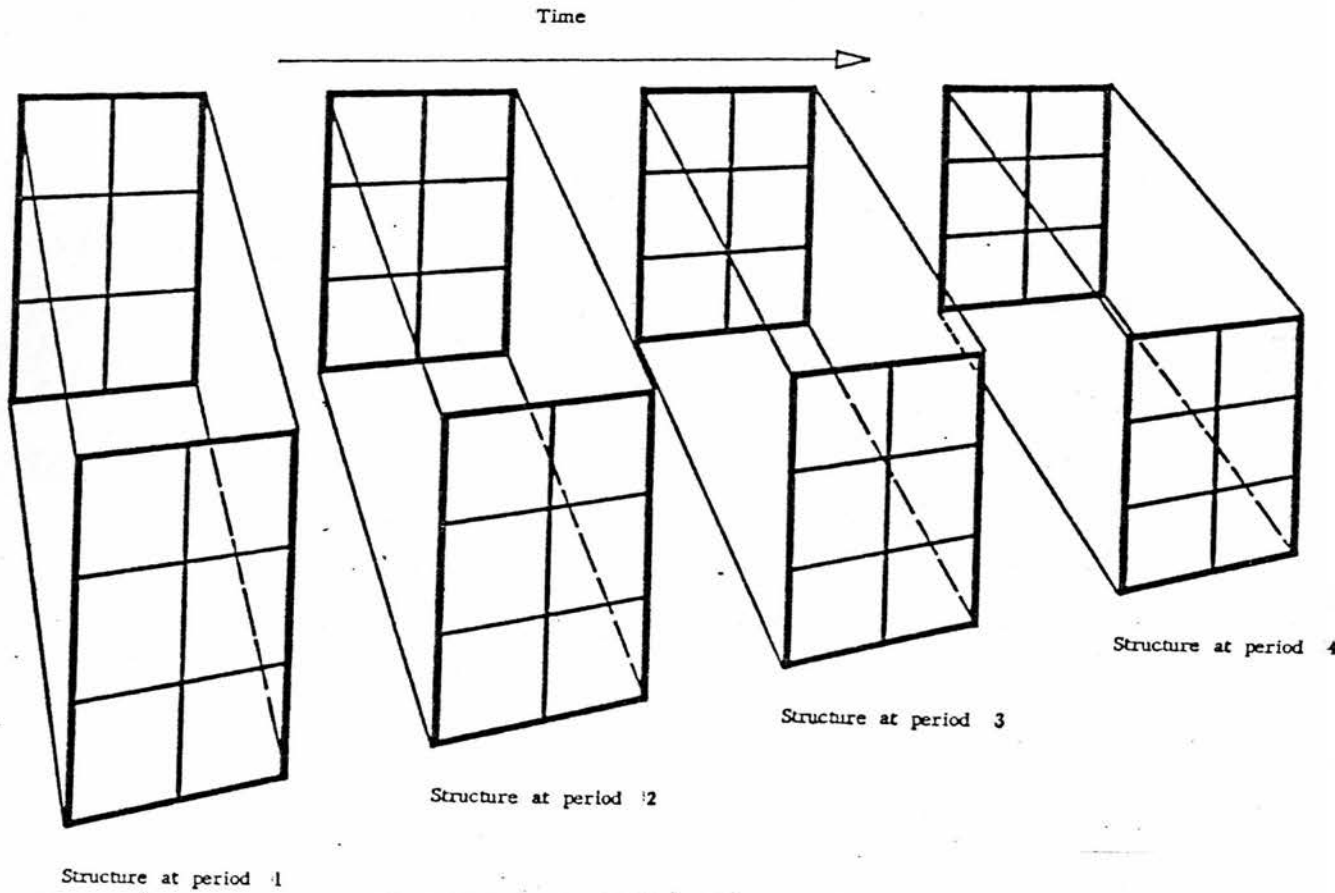


Fig. 4.8 (From Foley, p.40)

Without placing the same emphasis on functional and activity organization as the primary mediator between the institutional/aspatial and the environmental/spatial which Foley takes, the basic structuring implications of his conceptual framework can be accepted in their entirety, including the attempt to discuss present and potential contributions of environmental research

accordingly<sup>10</sup>. The path to be taken from the institutional/aspatial level of consideration to the environmental/spatial one is obviously a long one and involves a series of conceptual transformations which are quite difficult to comprehend outside the totality of built environment structures. A framework of the kind Foley constructs<sup>11</sup> is useful, therefore, not only in terms of the implementation of specific areas of research and suggesting the need for new ones, but more importantly in terms of evaluating and integrating these areas within a broader architectural context. It can be used to provide a categorization of the different epistemological backgrounds and conceptual bases from which this research originates, and at the same time account for its complex variety and multidisciplinary character.

But as it attempts to do so, it inevitably identifies gaps between the different types of knowledge produced. More significantly, it paves the way towards bridging these gaps and generating more effective knowledge. Within this, major considerations always have to be borne in mind: how, for example, architectural design actions are shaped, on the one hand, by the nature of the complexity involved in architectural structures themselves and, on the other, by the epistemological backgrounds and disciplinary bases from which the descriptors employed in describing these

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10. *The different conceptual bases and disciplines involved have been discussed and analysed extensively by Foley.*

11. *See Maravelias (1978) for some detailed discussion and comparative analysis on similar frameworks, especially within a climatic design context.*

structures and producing knowledge about and designing them originate.

Thus while Foley's framework was originally conceived in order to deal with large-scale metropolitan structure, it is, in fact, well equipped to aid the investigation of all types of built environment structure extending from the level of a building to that of a metropolis, since all these may be taken as special instances of architectural complexity and structure requiring the same conceptual basis<sup>12</sup>. It describes in a general sense the logical complexity to which architecture refers, while at the same time it can be used as a basis for identifying the various levels of this complexity, how are they to be resolved and what are the conceptual tools appropriate for their investigation within the totality of the whole structure.

An added advantage is the removal of the conceptual confusion usually made between the physical and spatial aspects of architectural structure. Physical arrangement is necessarily a spatial arrangement, but there are components of architectural structure other than the physical which also have spatial characteristics. These include activities, interpersonal relations and even normative ones where socio-cultural and other institutions manifest themselves spatially. On the other hand, all these aspects of structure (including the physical) have aspatial characteristics

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12. *Complexity is viewed here to be governed by how the system under consideration is defined and not by how small or big it is.*

and the first characteristics (the spatial) cannot be comprehensively understood without considering them within the context of the second (the aspatial) and *vice versa*.

Now, what may be viewed in this thesis as an architectural schema or prototype (even at its most abstract level of conception) involves in its totality a highly complex structure which is as comprehensive and logically complex as the one just discussed and which relates to any level of consideration of the built environment. Besides its spatial nature (which is usually taken for granted by architecture as also its environmental one), it equally involves aspatial characteristics and embodies an institutional, activity and environmental images. However, since it is the institutional/aspatial level which most of the time provides the start for design action (by defining a problem - if only when we say we want a house, or a school, and so forth) and at the same time establishes the predominant basis for the use and evaluation of architectural products, then, it is inevitable that the whole structure is eventually and predominantly evaluated on such a basis. Not only this, but whatever is used to describe or generate this structure must also be amenable to this evaluative mechanism.

This is particularly so if we realize the simple fact that there is a kind of inescapable duality in our dealings with architectural phenomena, in that, while our concepts about them may tend to be very general and deep (decentred), the focal point of our practical dealing with them remains equally particular

(centred) at the level of the individual built environment artefact (whether a building or a whole settlement) and the social use to which it is put. The more paradoxical aspect to this is that in the *decentred situation*, architecture - behaving like a science - tends to deal with abstract forms, while in the *centred situation* - behaving like a practice - it deals with objects as institutions or building types, such as houses, schools, hospitals and so on. Therefore, in describing or designing a building of a particular type and bringing it into reality, its institutional identity can never be ignored.

#### 4.7 ARCHITECTURAL STRUCTURE, MEANING AND SOCIAL EVALUATION

The institutional/aspatial base, of course, embodies many value systems (including the economic, aesthetic, political and so forth) which originate historically. These systems, undoubtedly, interact and have a structure of their own, but at particular occasions or historical moments (and without in any way eliminating the others), one takes precedence over the others and becomes the most influential system of social evaluation. For instance, the contemporary value system operating in architecture has tended to be dominated by broad economic values (the emergence of an autonomous subject like *building economics* serves to consolidate this). Accordingly, it is not surprising to find the primacy given to particular aspects of structure at one time becomes less at another.

For example, the present energy crisis has brought to concrete realization the fact that the built environment is part of a wider terrestrial system which is finite in resources and thus less resistant to waste and pollution, and that building decisions seriously affect the stock of organic energy reserves and extents of raw materials. Hence is the increasing priority accorded to the economics of the various contents of architectural energy consumption, especially in terms of achieving satisfactory levels of environmental performance and quality but with reduced waste. This, of course, does not mean that questions of economics associated, say, with planimetric spatial provision/use which have been dominant over the past two or three decades will in any way be completely ignored. Indeed, they remain active, but increasingly assimilated to the general context of environmental performance and its energy/(high or low) technology economics.

The involvement of social evaluation, in fact, influences even the choice of the methodological and conceptual tools invoked to investigate a structure. This is why we find from time to time various shifts in relation to the kind of descriptors employed and the kind of scientific disciplines consulted. It is clear, then, that *social evaluation is not external to a structure, but plays an internal structural role in investigating it*. It is involved both in the process of its production and also the descriptive tools that are necessary; it is involved both in its description and generation. And since the production of a product of high complexity such as the built environment takes place in

a historically created process, then so do the descriptive tools and the social systems of evaluation.

The strong involvement of historical processes and consequently of systems of social evaluation introduces the requirement that questions of 'meaning' have to be taken seriously into account in any attempt to investigate architectural structure (even at its most elementary and abstract level). In general terms, the articulation of meaning is essentially organized around predominancy and hierarchic integration. Integration says that built environment phenomena acquire their meaning and pragmatic value at synthetic levels<sup>14</sup>, the complexity of which can be approached adequately only within a multidisciplinary structural perspective. Multidisciplinary considerations, however, result in increasing complexity and, therefore, need to be simplified in order to be integrated. This is a common strategy in all spheres of knowledge and action where generalized assumptions are employed to simplify more complicated situations in order to keep them manageable.

But as there is a benefit in abstraction (whereby increased generality results in reduced complexity and hence easier integration), so there is a danger also. In describing reality as in experiencing it, we are limited by the nature of the conceptual tools we have at our disposal. Conceptual tools present

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13. *This, of course, takes into account the level of maturity of these descriptors and the disciplines that inform them.*

14. *Refer to Appendix I and II for elaborate discussions on this point. See also Chapters 6 and 7.*



themselves as a means for understanding reality, but they are at the same time a means for manipulating it. Their logic is reduction: the nature, for instance, of millions of built environments is reduced to symbols. They gradually become more abstract and far removed from their reality, and the methodological conditions we impose in order to discern an order among them is that they should remain so. We do not see built environment reality, but images of it.

And yet the meaning of reality does not end at the convenience of the media in which it is described. Built environments are facts of history and location. They have their specificity which somehow needs to be accounted for by any comprehensive architectural theory. Therefore, while there is a need for abstraction in order to achieve multidisciplinary integration, this integration, if it *is* not to lose its descriptive comprehensiveness and problem-solving capacity, should be kept at optimum levels of abstraction. An optimum level of abstraction is taken here as (borrowing the term from linguistics) the *syntagmatic level* (see Chapter 6 in particular).

#### 4.8 CONCLUSIONS

This chapter has dealt with the concept of space in some generality, but has progressively evolved the concept within architectural terms. It has examined the notion of *architectural space* and concluded that the most adequate way of investigating

architectural spatial phenomena is to analyse them within the totality of architectural structures.

As a methodological consequence, the need has emerged for adopting a structural approach which not only recognizes the importance of socio-cultural and institutional dimensions of architectural structures, but also organizes and presents the different images these structures take: their normative and institutional image, their functional and activity image, and their physical and environmental image. Architectural structures involve both spatial and aspatial aspects and, at deeper levels (the levels at which schemata and prototypes are conceived and internalized), the interdependence between their various images and characteristics is profound and presents a structural totality involving stable forms (morphology-synchrony), dynamic process (transformations) and history (diachrony) - within which appropriate systems of social evaluation originate (internal to the apprehension, description and generation of these structures and consequently present in the articulation of the conceptual tools employed in investigating them). This means that, although at certain levels of consideration the contribution of specific disciplinary descriptors becomes inevitable, the need for a more comprehensive and coherent structural logic seems unavoidable - in order to deal with the high level of logical complexity which is involved in architectural structures themselves.

The following part is mainly concerned with development of structural approach. It characterizes several aspects to this approach and also investigates their architectural usefulness and validity.

## PART II

### CHAPTER 5

SYSTEM AND STRUCTURE: THE STRUCTURALIST SOURCES OF  
STRUCTURAL APPROACH

### CHAPTER 6

THE SYNTAGMATIC DEVELOPMENT OF STRUCTURAL APPROACH

### CHAPTER 7

ARCHITECTURAL THEORY, DESCRIPTION AND PRACTICE

CHAPTER 5<sup>\*</sup>SYSTEM AND STRUCTURE: THE STRUCTURALIST SOURCES OF  
STRUCTURAL APPROACH

## 5.1 INTRODUCTION

The need for a structural approach was stated more than once in the preceding chapters, but acquired special significance and character towards the end of the last one. There, it became apparent that due to the high degree of logical complexity and integration involved in all types of built environment object-systems, a structural approach must initially be concerned with architectural realities seen in their totalities, before deciding which of their many particular aspects deserve further attention and what are the conceptual tools appropriate for their investigation.

The movement known as *structuralism* has contributed in several important ways to the formulation and elucidation of the principles on which such an approach might be based, and with this the notions of 'system' and 'structure' have received explicit attention. In this chapter, certain general aspects of

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*The discussion in this and the next two chapters is closely connected with the one contained in Appendices I and II - which are antecedent. Several highly specific points whose origin or elaboration is to be found in these two appendices are cited, but, for purpose of preserving the continuity of the rest of the argument, other general overlappings in theme or content have not been particularly stressed: this footnote being an acknowledgement.*

the structuralist argument are presented. This presentation is guided by its architectural relevance and hence duly evaluated.

## 5.2 THE LOGIC OF WHOLES VERSUS THE LOGIC OF RELATIONSHIPS

The case for a logic of systems seen as wholes as opposed to an atomistic logic of relationships (or a summative logic of aggregates) was well formulated by Angyal (1969, p.17).

"Our scientific thinking consists prevalently in the logical manipulation of relationships. That the structure of wholes cannot be described in terms of relationships has, however, been repeatedly pointed out by many writers. While accepting the premise that holistic connexions cannot be resolved into relationships, some authors have implied that the pattern or structure of wholes does not lend itself at all to logical manipulation. We suggest, however, that the structure of wholes is perhaps amenable to logical treatment after all, that, though it may not be described in terms of relations, it may be described in terms of some more adequate logical unit, representing an entirely different logical genus."

Such a 'logical genus' is characterized by Angyal as being capable of contracting an indeterminate number of 'elements' or 'relata' whose relationships cannot merely be ordered in a linear fashion or by means of their inherent or absolute qualities (as is usually assumed by the atomistic logic of aggregates), but most importantly by their place in an *organizing system*. An organizing system of this kind is a *holistic system*. Unlike an aggregate in which elements are *added*, in a holistic system elements contribute to the formation

of the system predominantly by their *positional qualities* and *arrangement*. Thus components of a system cannot be analysed by arbitrary reduction into pairs of relata: in a holistic system, "We abstract *constituents* ('elements') and refer only to the organization of the whole" (Angyal p.20, his emphasis).

It has been customary, argues Angyal (p.21), to consider relationships as existing between objects, which are separate or individuated and that for these relationships to exist a *dimensional domain* (a manifold) is necessary. A dimensional domain is also necessary for a system, but,

"The role of the dimensional domain for a relationship is merely disjunction of the relata. [It] does not enter into the relationship... [Whereas] the dimensional domain not only separates the parts, but it participates in the formation of the system.... *A system is a distribution of the members in a dimensional domain.*" Angyal, p.21, his emphasis)

Furthermore, while in a relationship the connectedness between relata is a *direct* one and *unmediated* (involving identity, diversity or similarity), in a system (from a holistic point of view), members do not need to connect directly with each other, but with reference to the whole. To emphasize this point, however, is not to argue that direct observable relationships do not contribute in an important way to the formation of systems; nevertheless,

"One thing ... seems clear, namely, that systems cannot be deduced from relations, while the deduction of relations from systems still remains a possibility. If that is the case then the more logical genus would be 'system', while 'relation' would be a reduced, simplified system which is adequate only for the logical presentation of very simple specialized constellations." (Angyal, p.25).

### 5.3 SYSTEM THEORY AND STRUCTURALISM

In modern epistemology, two movements have claimed to deal with systems as wholes: *systems theory* and *structuralism*. Systems theory has been founded on the analogy of the form of organization in biological (living) systems postulated as open systems and later generalized (as in Bertalanffy's *general system theory*) to cover all types of system in a manner which is envisaged to be interdisciplinary. Structuralism, whose greatest impetus came from the field of structural linguistics, has been largely concerned with societal and artificial systems, but it has progressively appealed for support in models of structural mathematics. Epistemologically, neither of the two perspectives could be shown to exclude the other in its entirety - though there have been arguments which are extremely critical of one or the other (such as Hillier and Leaman's (1972) in favour of structuralism and Wilden's (1972) in favour of an information-based open system theory). There are differences in formulation, of course, owing perhaps to fields of origin, concrete methodologies, predilections of individual authors and so forth; nevertheless, a degree of conceptual agreement can be shown to obtain.

Laszlo (1971)<sup>1</sup> maintains that the two perspectives in their original conceptualization do not argue for the reduction of one set of phenomena to the other (for instance, biological to

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1. The article by Laszlo (1971) draws a comparison between the basic premises of the two perspectives and holds out that there are isomorphies and uniformities (invariances) exhibited between their theoretical schemes. Consequently, he suggests the establishment of a 'hybrid' framework which may be able to interconnect them and hence bridge the gap between natural and social sciences.

physical) or imply that differences can be reduced to identities. Every system has its specificity and none is adequate to account for the organized complexity of another. Thus the diversity of phenomena must be allowed for. However, though the various systems that exist cannot be adequately explained by immediate reference to each other, these systems do not necessarily violate the laws of one another. For instance, biological organisms do not violate the laws of physics nor do societies violate the laws of biology. Therefore, the search for unity should not be sought at the level of direct analogy and identity of phenomena, but at a different level altogether, that is at the conceptual level - the level of theoretical models.

Theoretical models may reflect an isomorphism between themselves, but in no way does this prove the isomorphism of the phenomena to which they apply.

"Models<sup>2</sup> may be abstracted from the frameworks of their original reference and compared, and if found isomorphic, only the fundamental unity of nature need be affirmed in the corresponding respects, and not its undifferentiated identity. The latter would disregard the possibility that the models may apply to phenomena on different levels of organization and complexity, i.e. that the unity in question may be *hierarchical*, rather than linear."  
(Laszlo, 1971, p.190, his emphasis)

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2. *The general subject of models and their uses is, of course, an interesting one. There is no intention here to reproduce the debate on the merits of the different formulations. This has been dealt with by many competent authors whose own views continue to be analysed and elaborated both by themselves and others in numerous fields of enquiry. The discussion by Echnique (1972) which characterizes the nature of models and investigates their role in environmental design is illustrative.*



From the outset, then, systems theory and structuralism need not be sharply opposed to each other, since they can undoubtedly be supportive to, and involve a high perspectival measure of, each other. In fact, the shades of meanings are not easy to distinguish by the use of terms as complex and variable as system and structure. Nevertheless, within the context of this thesis, it is the contribution of the structuralist perspective which is often sought, mainly for three reasons.

First, architecture as a system is obviously more of the nature of societal and artificial systems (indeed, one of the most concrete) than of the nature of biological (living) systems. Thus a perspective such as the structuralist one whose chief origins are rooted in societal and artificial systems offers a more feasible entry.

Second, though theoretically systems theory makes similar pronouncements about the search for isomorphy at the level of theoretical models rather than of perceptual phenomena, methodologically (perhaps due to its biological origins, historical circumstances and concrete formulation) systems theory has been less resistant to the temptation of utilizing the huge stock of analytic models and techniques which owe much of their efficacy to mathematical applications within mechanistic and behaviouristic frames of reference. Consequently, applied systems approaches have themselves tended most of the time to be both mechanistic in their strategies and too analytic in their applications, thus the scope of the involvement of systems theory itself at the

synthetic level of investigation (with which this thesis is much concerned) seems severely limited<sup>3</sup>. On the other hand, structuralist theory deliberately avoids the behaviouristic/mechanistic question of what exact system a particular set of observables and their relations *determine* the existence of by positing the fundamentally different question of what system structure is there to be for certain observables to be *possible*. This automatically renders the actual an instance of the possible.

Recapitulated briefly<sup>4</sup>, the main objective of structuralist analysis is to establish a way of identifying the logical complexity of a system and how this logical complexity constrains and makes feasible the functioning of both the system and its constituent elements. The logical complexity of a system is the one embodied in its *structure*. Thus the essential properties of structure are logical and not substantial. Structure is always less than system because unlike system, structure does not exist at the *surface level* of observables, but at the *deep level* of their invariance; it being an abstract set of logical relations underlying the manifest richness of the

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3. *This is not to argue that the analytic level of consideration can be done without. At lower levels of complexity where the exact elements or parameters of the system are specified, analytic techniques are undeniably useful and, in fact, at the level, say, of design specifications they are inevitable. The argument here, however, is that the conditions under which these techniques apply must be first established by a theory operating at the synthetic level before any detailed analytic analysis can be fruitfully undertaken.*
  4. *The sources for structuralist argument are numerous, but for some lucid accounts, see Brittan (1972); Culler (1975); Glucksmann (1974); Lane (1970); Piaget (1971); Robey (1973); Rossi (1974).*

concrete system. Therefore, structure operates more like a theory for describing the basic principles that make the system possible than by determining the exact cause of its existence or the prediction of its behaviour. Structuralists argue that any real-world system is nothing but a transformation of its structure which incidentally is the structure underlying any of its parts (albeit in elementary form). Translated into Chomskyan terminology, what is observed or experienced at the level of consciousness or overt behaviour (the level of *performance*) is a *surface structure* which is a *transformation* on a *deep structure* that operates at the level of *competence*; the level of the unconsciousness. Deep structure, it is to be observed, is equivalent to the general use of structure adopted by all other structuralists.

Without subscribing to the extreme view advocated by some leading structuralists (for instance, Levi-Strauss) that it is possible to reach a level of unquestionable certainty in identifying real or permanent structures that are valid for all time, the structuralist idea of structure can be accommodated and assimilated to architecture<sup>5</sup>, especially within a design context, since in design the object-systems that interest us (that is the finished products) are still in the realm of non-observables. We can only reach them by theorizing their underlying structures and then transforming these into reality through further specification and physical labour.

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5. *Some important qualifications are included below in this chapter.*

The third reason in favour of the structuralist perspective is that any way of thinking which is to do with structure can hardly be seen as totally foreign to architecture - from a historical point of view. The term structure, with its associated words, is a key term in modern thought, but originally its use was exclusively architectural from the Latin 'structura', from the verb 'struere', to construct or build, implying primarily a noun of process: the action of building (Glucksmann, 1974, p.1; Williams, 1976, p.253). Subsequent developments in terminological uses assigned to the word a meaning which is still dominant today - though not exclusive - in that, while the principles of construction are seen as structural the general sense in which the term operates is that of *constitutive organization*. Thus arose the conventional differentiation between *structural* and *decorative* (or ornamental - accepted largely as to do with tectonics than structure<sup>6</sup>) which strengthened the sense of an internal structural organization that is relatively fixed and permanent, even hard, and which is to do with load-bearing parts of a building and that are resistant to the various systems of forces (gravitational, wind and so forth) acting upon it.

At present, of course, the term structure is part of a vocabulary available to most fields of enquiry<sup>7</sup>, where structure is seen to underlie all manner of objects (from physical to

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6. The comparative sense in which the terms 'structure', 'construction' and 'tectonics' are architecturally used can be followed in Sekler (1965).

7. The history of the various senses in which the term structure has been used and expanded in the different scientific fields is traced in a brief but informative manner by Williams (1976).

ideational) and this perhaps may account for the polysemic meaning it is increasingly acquiring. In fact, the multiplicity of connotations attributed to it doubts both the existence of a single definition or a precise methodological orientation which could be undisputably called *structuralist* and hence the conceptual complication surrounding the use of the term in general epistemology and consequently in specialized fields like architecture.

#### 5.4 STRUCTURE: INTENTIONAL OR OPERATIONAL

According to Boudon (1971, pp.16-7) the general ambiguity surrounding the concept of structure is to a large extent a result of its appearance within two types of apparently different contexts; one *intentional*, the other *operative*. In the intentional context, structure is used either to underlie the systematic nature of an object or to stress that a certain method can be applied in order to describe an object as a system. Thus for Piaget (1971), for instance, the conditions of *wholeness*, *transformation* and *self-regulation* are applied in a manner which is logically specific and which defines structure as a system of transformation under some well-defined transformational rules or operations which are both internalizable and reversible, but which are at the same time, subject to a principle of conservation or invariance that renders them commutative, and, therefore, jointly applicable to the same situation or problem. Piaget takes the mathematical group as the finest prototype of his

definition of structure.

In the operative context, the concept of structure is incorporated within a theory which attempts to account for the systematic nature of an object. Here the interest is not strictly centred on the concept of structure as such, although the very fact of attempting to analyse the structure of an object implies that a certain theoretical meaning is given to it as a concept. Examples of this are the syntactic linguistic structure as defined by the Chomskyan theory of transformational grammar or the various societal or literary structures defined by semiological structuralism; as, for example, in the anthropology of Lévi-Strauss or the literary criticism of Barthes.

However, the various positions taken by individual authors are far from being so neatly classifiable. For instance, while Piaget maintains an intentional definition from the outset and indeed an exceedingly formal one, his brand of structuralism (that is *genetic structuralism*) is *operational*, *evolutionary* and *constructivist*. It envisages structures as deep constitutive formations, but they are never permanent or fixed; they are continuously being built up and transformed at different stages in history or development.

"The being of structures consists of their coming to be, that is, their being under construction."  
(Piaget, 1971, p.140).

This runs counter to any suggestion that structures can be innate (as argued by Chomsky) or can be entirely synchronic and

isomorphic with a permanent human intellect (as argued by Lévi-Strauss).

The differences in outlook between Piaget's project and that of Lévi-Strauss and between their two brands of structuralism and other types obtain at various levels of detail, but it is not the purpose of the present discussion to investigate these differences. There are several levels of agreement and positive qualities in the various projects which are of general relevance to the argument developed here. However, before adopting any particular structuralist point of view, it must be stated that from the general point of view of this thesis, it is largely the *operational value* that we obtain from defining a structure which offers a realistic option, since (as explained in Appendices I and II) there can be no objective way of imposing any *a priori* conditions of defining a concept of structure (*as such*) and afterwards using this general concept to explain a particular set of architectural realities once and for all. What is firmly held here (and the possibility of its operation has been partly demonstrated in the previous chapter and is to be further investigated in the rest of this thesis) is that there can be a general construct which can be termed 'architectural structure', and, therefore, the search for it has meaning. However, this structure is neither unique in itself nor is it located at a single level of consideration. To define this structure with any precision at any particular moment in time, architecture must be considered as a totality whose object-systems have their specificity. Parallel to this, there must also be an



architecturally specific theory whose task is to evolve an operative definition of this structure, define its various levels of existence and manifestation, indicate its use, and give it coherence and contextual meaning.

From this point of view, then, the most obvious interest afforded by structuralist thinking is not a precise method or technique by which any object-structure will be automatically discovered, but the insistence that the theoretical premises underlying any such method should be made as explicit as possible so that they can be among the things held out for comparison and critical analysis. Closely connected with this is the structuralist argument against the conventional sharp distinction drawn between *description* and *explanation*. Instead, it is seen that the description of a structure simultaneously explains the object under consideration. The integration of description and explanation in this way is a reflection of the structuralist view of causation. Glucksmann (1974, p.147) lists and analyzes several tenets underlying this view, the most representative of which are<sup>8</sup>:

1. that the structure, though immanent, is manifested only in its effects - it is never immediately active so causation is mediated;

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8. *Excluded from these is the controversial issue of whether structure causes its effects exclusively synchronically, and thus less affected by history, or not. Many structuralists adopt the view that it is sufficient to account for structure at the synchronic level - a view rightly attacked by their critics. Piaget, among others, however, has amply demonstrated that structure needs not be so effectively at variance with history or for that matter function. Indeed, the historical dimension gives it vitality and justifies much of its significance and functioning. See Section 5.5 below.*



2. the elements and levels of the structure and the relationships between them may be of different natures and weightings so that any structure consists of several types of determination;
3. that there is no one to one relation between cause and effect and that *contradictions* and elements are likely to be 'overdetermined' (that is each is due to several causes and has more than one *raison d'être*);
4. that although one of the levels may be 'determinant in the last instance', the dominant role in the structure may be taken by another level.

Thus the desire to be rigorous and systematic does not necessarily entail attempts at causal explanation of the cause-effect chain type. Other highly suggestive notions include Piaget's idea of 'reflective abstraction'.

#### 5.5 REFLECTIVE ABSTRACTION, PROBLEM-SOLVING AND MEANING

By *reflective abstraction*, Piaget (1971, p.19) means that properties are derived "from our ways of *acting on things* [and] the operations we perform on them", rather than by the much simpler and more direct form of abstraction which draws properties *out of things*. The deep character of reflective abstraction implies that the operations performed are necessarily *internalizable* (i.e. cognitive or symbolic) *actions* which, in turn,

means that they can be re-externalized or objectified in the form of communicative codes, systems of classification and so on, and, therefore, need an *internalizing/externalizing subject*. Piaget refers to this subject, which is the centre of activity, as the 'epistemic subject', thus emphasizing its collectivity and guarding against any conventional association between it and a spontaneous egocentricity or an isolated individual psyche or consciousness.

The object insofar as it can be acted upon, and, therefore, *known or used or related to* by the subject is an indeterminate entity whose definition at any given moment is relative to the actions and operations of the subject. This is not to argue that the object is wholly arbitrary. The object is never completely lacking in autonomy or substance. It imposes constraints and defines limits on the appropriateness of the actions that are brought to bear on it, and, therefore, enters reflexively into the subject's symbolic and cognitive schemata. In this sense, the historical dimension can be incorporated, in that the subject's actions (conceptual or sensorimotor) take place at particular historical moments. Most importantly, these actions are largely aimed at solving problems<sup>9</sup> which the subject faces in its interaction with its environment, and hence evaluation is also part of all aspects of its activity.

It is all this which (as has been observed in Appendix I)

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9. *Some of these problems could be entirely conceptual as is faced, for instance, in much theoretical scientific research activity.*

has made Piaget, and many other authors<sup>10</sup>, conceive of reflective abstraction in close connection with the Marxian concept of '*praxis*' - that is of human practice. Thus reflective abstraction can be made *anthropocentric*, but without necessarily losing its generality. The practical significance of this general remark is that it shows the way in which it is possible to answer the important question of: at what abstract level, especially in sciences of the artificial - such as architecture, should the investigator attempt to locate the structure of the object under investigation? This question implies that any abstraction is of little value if it is not to solve the problems (practical or theoretical) which have produced it. It is in response to problems that conceptual tools find their significance and acquire their operational value.

In artificial systems and certainly in architectural ones, human action is involved throughout. It is involved in their production, consumption and in devising the conceptual tools that are appropriate for their description. And with such a deep involvement of the human subject, the nature of the meaning attributed to these systems becomes of paramount importance. However, though *genetic structuralism* recognizes the importance of questions of meaning and indeed can be quite helpful in identifying them, it is less able to deal with their particularity

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10. See, for example, Harvey (1973). Incidentally, Lévi-Strauss in much of his writings (see, for instance, his 1966) also maintains a conception of myth or primitive art as an imaginary resolution of some real social contradictions which for all practical purposes can be viewed as nothing but problems.

because of the extreme generality and high interdisciplinary character of its project. It is here that the contribution of *semiological structuralism* needs be sought. This is to be discussed and reconciled with the genetic one in the next chapter.

## 5.6 CONCLUSIONS

The discussion in this chapter has reaffirmed two main points about the structural approach. First, a structural approach, besides recognizing the specificity of architectural realities and the contexts in which they occur, must go beyond the level of their surface manifestation and habitual observation and establish how they manage to be continuously transformed while at the same time maintaining an internal order and structural coherence which gives them meaning and guarantees their appropriate functioning. Secondly, whatever object one is dealing with, its structural analysis is a product of a theory, but the construction of theory depends primarily on the nature of the object considered and on the derivation of the appropriate conceptual tools that permit the analysis of this object as a system.

In other words, the concept of structure does not apply until it is decided to consider a given object as a system. However, structure is essentially a logical construct which informs us about the object and not an undisputable or exact mapping of it. Quite significantly also, it is not the attempt

to try and pinpoint a definition of the word structure which constitutes its utility, but the sense of being able to develop an idea of it *operationally* and relate it to a given context. Because of this, the structuralist perspective has been accepted (with qualifications) mainly at the conceptual level of its formulation. There is no precise structuralist method or technique which, when applied to an object, automatically discovers its structure. Nevertheless, there is a kind of theoretical attention which one might call structuralist and which gives coherence and intelligibility to the conditions under which any such a method or technique may apply.

## CHAPTER 6

THE SYNTAGMATIC DEVELOPMENT OF <sup>THE</sup> STRUCTURAL APPROACH

## 6.1 INTRODUCTION

*Semiological structuralism* whose origins go back to Saussure has developed out of the general assumption that theories of structural linguistics are directly or indirectly applicable to other aspects of human culture insofar as all of these may be interpreted like language as systems of signs and communication. It emphasizes the way in which meanings of events or objects in the socio-cultural world are conventional or socially produced rather than being entirely natural or directly causal. In Section 3.4, the present trend of formulating architectural approaches that rely heavily on semiological structuralism as a methodological background has been referred to and several difficulties with these approaches were shown to obtain.

Nevertheless, the architectural value of semiological consideration still holds. For instance, the notion of meaning which is implied by semiological structuralism is crucial to architectural description, particularly in the general form of meaning, that is of 'social evaluation'. Furthermore, there is a level (that is the *syntagmatic level* - which constitutes the major theme in this chapter) at which the advantages of both genetic (general and abstract) and semiological (socially meaningful) approaches may

be resolved. In either circumstance, brief references to some basic theoretical arguments founded in modern linguistics are imperative. The references contained in this chapter, however, are guided by their specific relevance to the discussion developed below, rather than a reproduction of the technical details of linguistic method itself in its various versions.

## 6.2 THE SCOPE OF LINGUISTIC MODEL AND SEMIOLOGY OF SIGNS

In the series of conceptual characterizations which the 'linguistic model' gives to language, two Saussurean distinctions have been decisive: *la langue* and *la parole*, referring to *language system* (a socio-cultural institution governed by rules and norms) and *language behaviour* (manifested in actual speech utterances and writing), respectively. In Saussure's (1917, but see edition 1974) view, language (or *langue*) - as distinct from speech (or *parole*), language *synchronically* considered - is fundamentally *differential*. It differentiates between linguistic items or signs (which Saussure took essentially at the level of words) by setting up *syntagmatic* (contiguous) and *paradigmatic* (classificatory or taxonomic) relationships<sup>1</sup> within which any word can be highly individuated and receive an identity of its own<sup>2</sup>.

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1. According to a general characterization made by Lyons (1973, p.12), "syntagmatic relations which an element contracts are those which derive from its combinations with preceding and following elements of the same level... paradigmatic relations contracted by an element are those which hold between the actually occurring element and other elements of the same level which might have occurred in its place."
  2. This is based on both the sound image or written form (signifier; significant) a word takes and the concept or idea (signified; signifié) to which it refers.

And this may be argued to be what prompted Saussure to postulate semiology as a science of signs piloted by linguistics<sup>3</sup>.

The difficulties with the search for signs *qua* signs (or their Peircean and other semiotic variants; *symbols*, *icons*, *indices* and so on) in architecture are many, but the following is both fundamental and sufficient. For while in language, words (or other linguistic items) are undeniably means of expression and communication, in architecture the notion of communication, though involved, is seldom that obvious. After all the bulk of architectural artefacts are not intended for pure communication; they are objects of use in themselves. These objects are not signs as such, but are in the nature of what Barthes (1967; 1973) describes as second order (indeed one may say third order or even higher) semiological systems. These are systems which are constructed or elaborated on the basis of highly permuted units that largely exist before them and which have already undergone extremely complicated processes of culturalization and are treated most of the time as commodities dominated by their use value.

Furthermore, whatever is taken as an architectural sign, the meaning it is said to communicate or signify neither comes to it as totally arbitrary nor remains unique to it. For instance, a

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3. Culler (1976, pp.91-2) has pointed out, however, that in suggesting linguistic as a general model for semiological investigation and emphasizing the arbitrariness and conventionality of its signs, Saussure was not arguing that all signs are wholly arbitrary, but was trying to suggest that through this one may be able to avoid the familiar mistake of assuming that signs which appear natural to those who use them have an intrinsic meaning and involve no conventions.



column not only signifies vertical support in a linguistic sense, it functionally acts as a vertical support. On the other hand, the function of vertical support is not in any way a unique property of columns, nor are columns entirely restricted to function as vertical supports. Load-bearing walls also function as means of vertical support and, in turn, they have functions other than this, such as acting as climatic filters, barriers to human circulation and so forth. Moreover, while a column may be of the nature of a skeleton structure, at other times it may not be clearly so, as when a structure is a mixture of load-bearing walls, columns and lintols. Add to this the kind of building materials that are likely to be used, geometrical shapes, methods of construction, processes of production and so on, and the complexity that is involved is no longer one which can be dealt with appropriately by a procedure which is insistent on identifying individuated language-like signs in architecture.

It is quite obvious that in architecture, signs do not just persist concretely so that they may be readily apprehended from the outset. What seems to be involved is that there are varied and multiple domains of signifiers (these usually tend to be called forms by architects) and there are varied and multiple domains of signifieds (usually called contents or functions), but the correspondencies that obtain within and between the various domains on either side or their opposites or their elements are - apart from very rare instances - never of a one to one nature. They are in the nature of dynamic structures which are both

highly synthetic and invariably multi-valued and subject to continued permutation and transformation.

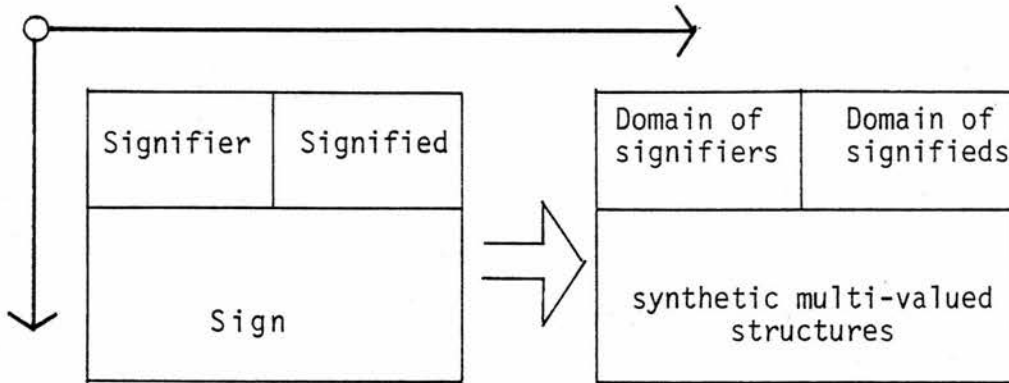


Fig. 6.1

Language itself exhibits this property. One of Saussure's major contributions to the study of meaning in language is his rejection of the idea that meaning is inherent to words. For him words only *acquire* their meaning according to their place within language as a system which confers it on them as a result of a 'social contract'. Consequently, he accepts that within everyday discourse, the most viable level of meaning generated by language and experienced by its users is to be found at the level of *structural solidarities* holding between words, and these structural solidarities are basically (but not exclusively) exhibited in *syntagmatic formations*, where a syntagm is formed out of the combination of contiguous units supported by linearity (Saussure, 1974, p.128).

### 6.3 THE MAJOR CHARACTERISTICS OF THE IDEA OF SYNTAGM IN LINGUISTICS

Three significant points need be stressed in connection to Saussure's definition of syntagm. First, the notion of syntagm applies not only to a particular type of grouping of words, but, more generally, to all levels of groupings including the formation of words themselves and extending hierarchically to cover complex units of all length such as compounds, derivatives, phrases, whole sentences, combination of sentences, and as pointed out by Barthes (1967, p.65), even whole texts.

Secondly, the definition of syntagm involves a spatio-temporal order, albeit a linear one. Barthes (1967, p.58) has stated this most clearly.

"... syntagm is a combination of signs, which has space as support. In the articulated language this space is linear and irreversible (it is the 'spoken chain'):  
two elements cannot be pronounced at the same time ..."

Thirdly, it is not enough to consider the relation that ties together the different parts of syntagms, but how these parts relate to the wholes and how the wholes relate to the parts. And, therefore,

"between the syntagmatic groupings, as defined, there is a bond of interdependence; they mutually condition each other. In fact, spatial co-ordination help to create associative [paradigmatic] coordinations, which are in turn necessary for analysis of the parts of the syntagm." (Saussure, 1974, p.128).

In all three cases, we see Saussure establishing links between language and meaning at the level of fundamental structuring operations, but predominantly as exhibited in the nature of

syntagmatic formations. Now, the fact that syntagms are based on structuring operations, that they are chiefly responsible for the generation of meaning in concrete situations, that the way they generate meaning is indeterminate (but also restricted both structurally and contextually), that they are spatio-temporal, and that they function at the level of system but also recognizable at the level of everyday discourse to those who use or encounter them - all of these offer a concept which is easily extendable to architecture, without in any way implying that architectural realities are reducible to linguistic realities or that architecture needs to be systematically distorted or lose any of its specificity in order to be investigated syntagmatically. By contextually redefining the term syntagm and broadening its scope, it is possible to assimilate to architecture a concept which is strikingly rich, highly synthetic and can be made rigorous at the same time. It should now be possible, in the light of this argument, to offer a preliminary statement of the scope and limitations of the notion of syntagm and its functioning within architecture.

#### 6.4 SYNTAGM AND PROTOTYPE

It has just been shown that syntagm in language inheres at various levels of hierarchic combinations and that it carries with it both an intuitively intelligible structural organization as well as a meaning which is socially produced and evaluated.

When examining everyday experience in the architectural environment, we find that it is organized on a basis almost comparable to that of everyday discourse. Everyday architectural experience rarely expresses itself in terms of isolated spatial units, but appears to operate on spatial domains which are roughly analogous to those of syntagms, where configurations of series of spatial units are structured in the neighbourhood of each other in a manner which offers dense functional possibilities that none of these constituent spatial units could support on its own. The richness of this experience is reflected both in the complexity of the observed social use to which these spatial domains are put as well as in the cognitive schemata held about them. It is only sufficient to consider terms like *bedroom, kitchen, house, hospital, district, neighbourhood, village, city* and so on to discover that they carry with them spatial descriptions which reflect certain modes of functional behaviour and social significance as well as modes of spatial organization *within* and *between* themselves which have long been intuitively intelligible to us through everyday use and socialization. To be sure, these schemata do not just refer to entirely physical entities or things like buildings, building elements or the actual materials from which these are constructed, but rather to more general notions which include both experiential and virtual characteristics that are of the nature of syntagms or some comparable spatially structured formations. In effect, it is reasonable to suggest that the most elementary architectural configuration is already a

syntagm - invested with meaning as well as being structurally coherent. And though it may not be (as its linguistic counterpart is also) radically open to complete formalization, still it can be made specific when referring to concrete situations.

An appropriate generic term which gives the true sense and real importance of a concept like syntagm is that of *the architectural prototype*<sup>4</sup>. Like linguistic syntagms which can be reproduced at the level of actual discourse and also as underlying structures, architectural prototypes can be reproduced at the level of the actual environment and also as underlying descriptive/generative structures. Indeed, the way the idea of prototype compares and covers a valuable notion such as that of syntagm has been put more clearly in Appendix I (pp.320-1).

"The function of prototypes in architectural practice has characterized its whole history both at a 'language' level by producing different styles and at a 'speech' level by influencing the individual way in which architectural surface structures have always been produced. What we propose here is that prototypes do not constitute anything but syntagms, in which the semantic component cannot be isolated from the syntactic one. Particularly in architecture prototypes have played the role of 'already structured' elementary units which have always carried a special meaning."

Now, it is interesting to remember that syntagms are, for Saussure, systematic and constitute the raw material out of which the linguistic structure is identified and acquires its communicative value. In this sense, syntagm is very near to (but not quite synonymous with) speech. Saussure was rather

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4. Section 3.2.4 relates the concepts of schema and prototype. See also Chapter 9 for further discussion.

careful to specify in what way syntagm could not be considered as speech, yet so near to it. Barthes (1967, pp.62-4) clarified this argument by emphasizing that:

1. there exist fixed syntagms, which usage forbids us to alter in any way and which are out of reach of the combinative freedom of speech (these *stereotyped syntagms*, therefore, become sorts of paradigmatic units)<sup>5</sup>;
2. because the syntagms of speech are constructed according to regular forms which thereby belong to the language, there is, therefore, a *form* of the syntagm dealt with by *syntax* which, is, so to speak, the 'glottic'<sup>6</sup> version of the syntagm.

More importantly, Barthes (p.62) insists that this *structural proximity* of syntagm to speech is an extremely important fact,

"because it ceaselessly offers problems to be analysed, but also - conversely - because it enables a structural explanation to be given of certain phenomena of 'naturalization' of connoted discourses."

This intermediate role which is attributed to syntagms is remarkably similar to the one which has been repeatedly attributed to prototypes at various instances in the previous

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5. Cf, for example, prefabricated units, building systems and so on.

6. 'Glottic': which belongs to the language as opposed to speech.

chapters. Prototypes, it has been argued, are to be viewed as highly synthetic structures obtainable at intermediate levels of abstraction. Their role is to guarantee a minimum level of stability and to provide a key-link between theory and practice and to act as a means for describing the built environment, at all levels, as well as a means for designing it. They are not surface phenomena in themselves, yet not entirely isolated from the rich level of observables, since they realize their potential and material existence in it. Prototypes are understood only because they are already *virtually* contained within the architectural environment. And as linguistic syntagms can be subject to analysis in terms of their deeper syntactic structures and still maintain their freedom of combination to produce new and wholly novel discourses so are architectural prototypes. They presuppose a structural organization that is relatively persistent and amenable to some form of analytic treatment, yet they retain a property of fundamental incompleteness that makes them flexible, dynamic and open to transformation and hierarchic permutation. They continuously negate their actuality only to reintroduce it enriched with new possibilities that obtain within various operational contexts. Hence they can be employed creatively in the process of producing new architectural realities as yet non-existent, and, therefore, linking existent and past realities to possible and future ones, but which can only be grasped within historical limits and constrained by culturally emergent conditions of usage. If their pragmatic value continues



to change, then that is because they are always entering *reflexively* into new relations within and between themselves and with their operational contexts: new relations which not only transform them, but the architectural system itself. More significantly, it is the concrete problem situations to which both designers and users (through usage) attend that present the ultimate test for the usefulness of any one prototype and establish its pragmatic value at specific moments in time.

It is obviously tempting given the above illustration, to suppose that linguistic methods can be directly applied to investigation of architectural syntagms or prototypes, but this would unquestionably be an over-simplification. First, in evaluating its syntagms language gives predominancy to their communicative value. This is essentially a secondary value to architecture (see below, Section 6.5.3).

Secondly, in language the chance of combining words with each other to produce linguistic compositions seems virtually unlimited. In architecture, however, the material resources involved in the realization of its compositions are limiting, thus restricting its productive (or 'speech') freedom to such an extent that it is rarely, if ever, carried out prior to some elaborate decision-making and evaluative processes. In fact, the kind of language which is involved in this aspect of the architectural system (that is its design and production) belongs to what Barthes (1967, p.31) has called 'fabricated' languages or 'logo-techniques'<sup>7</sup>. Languages

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7. Cf Simon's (1969) term '*sciences of the artificial*'.

of this kind, says Barthes, are not usually elaborated by a 'speaking mass', but by a 'deciding group'.

Unlike natural language, the fundamental origin of *logo-techniques* is essentially utilitarian (involving high material contents) and not simply a signifying one. The user's freedom to elaborate on them is limited to the *usage* of their products and not the *production* of the products themselves. The decision-making group which is involved at the origin of any such system can be more or less narrow; it can be a highly qualified technocracy (for instance, professional architects). It can also be a more diffuse or anonymous group (for example, the builders of vernacular or traditional architecture). The fact, however, still remains, this decision-making group does not involve every member of the community in a democracy of decision-making; the way natural language does with the mass of its speakers. This, it may reasonably be argued, is what makes languages that are elaborated by decision and utilitarianly-based evaluation practically open to ideological manipulation, if it is not entirely part of them.

The third feature which differentiates <sup>the</sup> linguistic syntagm from the architectural one is that since language is fundamentally an auditory system, its syntagms unfold *spontaneously* during a passage of time. In architecture, syntagmatic relations do not in principle presuppose (though by no means exclude, especially during construction processes) a linear ordering of units, such that the substantial realization of one element must precede or

follow the substantial realization of another in time and place. Architecture usually displays and juxtaposes its elements all at once and imposes on them a physical existence in volumetric space. For instance, it is not unusual to experience being in a particular room in a particular building, but at the same time in a particular neighbourhood or a whole city. It is this simultaneity which is basic to syntagmatic formations in architecture, and that is perhaps what makes them usually experienced as extremely dense functional totalities.

However, having said that, simultaneity as such is not a property that can be entirely denied to language for it is important to remember that in reality what we tend to apprehend when we encounter a linguistic syntagm is not exclusively restricted to its particular sequential ordering where one term leads to the other, *but the total structure that unites these terms*, that is the larger unity which is the syntagm or, more importantly, the whole context in which the discourse itself is taking place.

## 6.5 THE LOGIC OF SYNTAGMATIC STRATEGY

### 6.5.1 The Priority of Syntagmatic Considerations

Within modern linguistic theory proper, the logical priority given to syntagmatic consideration over other considerations has proved the most productive. Pettit (1975) deals with this in some detail and makes a convincing case for the development of what he

calls *syntagmatic structuralism* which is to be applied to the customary and non-literary arts<sup>8</sup>. He argues (p.11) that it is due to the difficulties faced in finding, from the outset, precise features or attributes by which to differentiate things paradigmatically, that the syntagmatic approach seems to provide a more feasible strategy. In linguistics, what the syntagmatic approach has attempted to do is to describe linguistic items in such abstract features as, for instance, 'noun phrase', 'verb phrase' and so on in order to formulate first the syntagmatic rules that unite them and circumscribe their operational meanings before resorting to a detailed analysis of what is special to any particular item in itself or what specifically differentiates it from all others.

However, the real importance of the syntagmatic approach lies in its logical understanding of the concept of syntagm as involving *a simultaneous reference to both syntactic and semantic levels of consideration* of the phenomena to which it applies.

#### 6.5.2 The Syntactic Component

The underlying syntactic implications of the syntagmatic approach are the ones which, of course, found an explicit and rigorous formulation in, and explain much of the power of, the Chomskyan theory of *transformational generative grammar*.

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8. Barthes (1967, p.61) also argues the logical priority of syntagmatic consideration in any semiological system.

Chomsky (1965)<sup>9</sup> argues that it is the study of syntactic structures which should form the core of linguistic method. According to his theory, language is still a system as characterized by Saussure whereby meaning is produced, but this production is fundamentally based on rule rather than taxonomic typologies. That is, language is more than a system of interrelated units; the relations which compose it are also a system of rules, and it is this aspect that Chomsky emphasizes in replacing Saussure's *langue* and *parole* with his *competence* and *performance*, respectively (Culler, 1976, p.83). Consequently, what he offers is a *generative syntax*, the core of a *transformational generative grammar* (which also includes a phonology and a semantic component) that forms a body of recursive rules by means of which any sentence of the language - and only a sentence of the language - can be given an abstract 'structural description' (Pettit, 1975, p.15).

Chomsky, however, insists that the grammatical rules so constructed do not imply that is what the speaker/hearer consciously knows about language, but merely that they represent the best analysis of what he does when producing or understanding speech utterances.

"To avoid what has been a continuing misunderstanding, it is perhaps worth while to reiterate that a generative grammar is not a model for a speaker or a hearer. It attempts to characterize in the most neutral possible terms the knowledge of the language that provides the basis for actual use of language by a speaker-hearer. *When we speak of a grammar as generating a sentence with a certain structural description, we mean simply that the grammar assigns this structural description to the sentence.*" (Chomsky, 1965, p.9, my emphasis)

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9. See also Lyons (1970), for a good summary and critical analysis of Chomsky's theory.

It is in the context of this clarification and the primacy given to 'description' that the question of meaning which the syntagmatic framework involves is to be approached. A convenient entry is to see how *semantics* is related to *syntax* in linguistics.

### 6.5.3 The Semantic Component<sup>10</sup>

According to Pettit (1975, p.27), in the modern linguistic theory which is based on the Chomskyan model of grammar, any sentence will have an abstract *deep structure* to be described by one (base) set of syntactical rules and a *surface structure* (at the level of observables) derivable from the deep one by another (transformational) set of rules; the deep structure will be common to a number of sentences which differ on the surface, and those sentences will have roughly the same meaning. Consequently, semantics is to be conceived of as dealing with deep structure and as providing a 'semantic representation' of it. How this semantic representation comes about has been a subject of controversy, but two important views are described below.

In Chomsky's (1965), semantic representation is derived from the deep syntactic structure as follows (Fig.6.2):

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10. *The discussion included in this section is highly dependent on the elaborate one presented in Appendix I, Section 4 and also generally on the overall argument presented in Appendix II. Various modifications, exclusions and appropriate elaborations have been introduced in order to establish a coherent argument.*

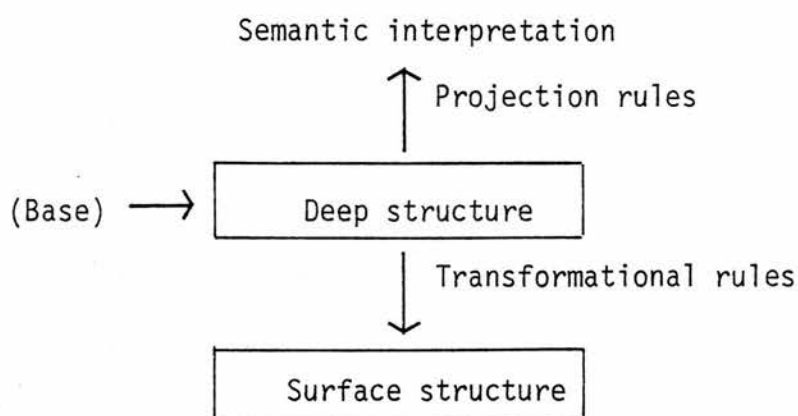


Fig. 6.2 (After Leech, 1974, p.328)

By 1970, Chomsky revised this model to the following one (Fig. 6.3):

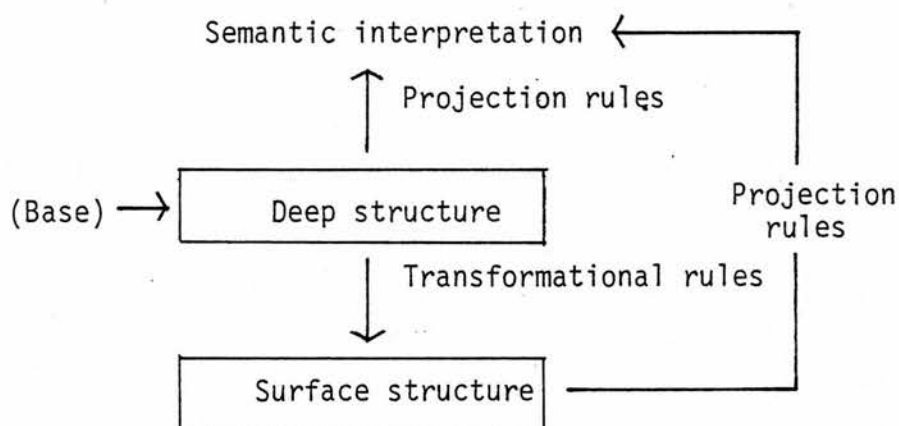


Fig. 6.3 (After Leech, 1974, p.329)

Both Chomskyan versions constitute what has been called the 'interpretive approach' to semantics, and thus have been distinguished from a recent approach called the 'generative' one

(Leech, 1974, p.324). According to the *generative* approach semantic interpretation is no longer derived from the purely syntactic deep structure, but the structure is so deep (this is what is called the 'base' in the Chomskyan versions) as to be identical with semantic interpretation. In this manner projection (or mapping) rules disappear and the model becomes as follows (Fig. 6.4):

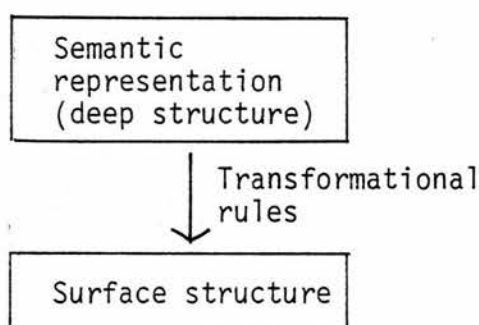


Fig. 6.4 (After Leech, 1974, p.330)

Many important questions of theory and method arise in connection with the nature of linguistic semantics that go far beyond the present discussion. Little further reference will be made to them here, except to note that the sense in which the *syntagmatic structural approach* has been adopted by this thesis is in the spirit of the *generative* approach to semantics than that of the *interpretive* one, because it accepts the involvement of meaning at the very bases of the structures it investigates rather than seeing it as an *addendum* or *epiphenomenon* to them. The syntagmatic approach as an envisaged framework for investigating architectural structures has less to do with a purely



Chomskyan interpretation that subscribes to an entirely mapping mechanism whereby a formal syntactic structure is established first and a meaning is assigned to or mapped on it later - in the absence of both its functional contexts and historical characteristics. Indeed, instead of depending on a purely rationalized or designatory syntax, it is advocated here to adopt what might be generically called 'syntagmatic syntax'.

#### 6.5.4 Syntagmatic Syntax and Social Evaluation

*Syntagmatic syntax* is a syntax which operates mainly at synthetic levels where the generation or description of a structure can be socially evaluated. The important difference between it and a purely designatory or rationalized syntax is that the latter usually tends to be single-valued, and originates in other scientific fields, while syntagmatic syntax comes primarily from the problem area and can embody more than one descriptive tool for formally describing a structure. The multiple descriptive tools it embodies are neither fixed (they remain open in number, type and level of formality: they can be added to, excluded from or hierarchically arranged) nor are they expected to be totally isomorphic (being made of different substances). Indeed, it is the *contradictions* and *anomalies* that may exist *within* and *between* the images they create which offer potential for renewed transformation, restructuring and regeneration of a structure, and which create the necessity for design action itself. Design

action is fundamentally founded on the realization of the obvious lack of correspondence between the various images of a structure. It is aimed at removing (by introducing new conditions) observed contradictions and anomalies which get solved only to reappear in new forms or replaced by equally demanding ones.

This way of interpreting the idea of syntax allows us the possibility of dealing simultaneously with several images of a structure. It is a syntax which is pragmatic in nature and not rigidly prescribed. By definition, it would incorporate characteristics of an historical moment (such as the acceptance of a given set of descriptors or a particular system of social evaluation), the realization of contradictions and anomalies within and between the images these descriptors create and an hierarchy according to which such anomalies offer potential for transformation and practical manipulation, especially when it comes to design action and solving new problems or improving on old solutions.

An advantage of this understanding of syntagmatic syntax is that systems of social evaluation are included in the methodological tools of the syntax and are not entirely external to it as is usually presumed in rationalized syntaxes. Social evaluation thus becomes a dialect for understanding the whole multidisciplinary nature of a structure and not a language limited to a particular image of it.

The issues connected with this particular argument are in the nature of 'descriptive theories' in general and those of architecture in particular. The latter are dealt with extensively

in Appendices I and II and a summarized discussion is presented in the next chapter. But before bringing this chapter to a close, it is worth including (as a quotation) part of the general argument which has been developed in Appendix I on the nature of social evaluation and the kind of systems of social evaluation involved in architecture, especially.

The historical evolution of the social evaluation of products - which at first sight might be only evaluated semiologically - means that we accept that each particular historical period is characterized by a particular balance of systems of evaluation. Communication - and consequently communicative value - is, of course, only one of them.

Systems like painting, music and language<sup>11</sup> have always been dominated by communicative values, while architecture shows a different history. For instance, it is quite easy to understand that communicative value has dominated the production of artefacts as far as official or religious architecture is concerned, from the pyramids to the contemporary phenomenon of returning, at a morphological level, to the deep structure. This *return* is supposed to facilitate production, and produce another kind of communicative value by the very acknowledgement of this return. Banham (1960, p.321) emphasizes this point when he speaks about *functionalism*, arguing that:

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11. For further comparison between these systems and architecture, see Appendix I, pp. 317-9.

"Under these circumstances it was better to advocate or defend the new architecture on logical and economic grounds than on grounds of aesthetics or symbolisms that might stir nothing but hostility. This may have been good tactics - the point remains arguable - but it was certainly misrepresentation. Emotion had played a much larger part than logic in the creation of the style; inexpensive buildings had been clothed in it, but it was no more an inherently economical style than any other. The true aim of the style had clearly been, to quote Gropius's words about the Bauhaus and its relation to the world of the Machine Age, "... to invent and create forms symbolizing that world" and it is in respect of such symbolic forms that its historical justification must lie."

What may be added to this is that the deep structure of this contemporary symbolism signifies - not in terms of each architect's emotional reaction, but in terms of social evaluation - the development of an economic basis of symbolism and what is more important, the beginning of the 'internalization' of this development.

Such an *internalization* has already dominated other fields of description of human practice and one of the most important deep characteristics of contemporary architectural thinking is that it does not only assume the significance of an economic basis in the limited symbolic context of architecture, but also acknowledges the necessity of the interdisciplinary character of it. In fact, it should not be a surprise to see <sup>the</sup> economic basis as constituting a fundamental system of social evaluation in architecture, primarily because of the hardware operations and extent of material resources (including land) and the huge scale of human labour involved in producing architectural artefacts, and consequently the difficulty of trying to reproduce them at

costs which are significantly less than those of the originals. And this may partly explain why the process of production in architecture still remains a largely *one-off* process and is comparatively less organized than in many other industrial systems.

## 6.6 CONCLUSIONS

In this chapter the structural approach has been explicitly equipped with syntagmatic interpretation whose initial definition and understanding originates in semiological linguistics. Its architectural extension and characterization does not represent a precisely isomorphic translation, and it has been contextually redefined and closely related to the notion of the architectural prototype. The main value of using a syntagmatic strategy is that it embodies a semantic dimension dominated by social evaluation which is historically produced and which plays an internal role in characterizing a structure even at its very elementary formation.

The structural approach, syntagmatically characterized, has in its theoretical foundation the advantage of introducing a point of view which is at once synthetic and rigorous. It is synthetic because it starts with the meaning involved in structures as totalities and not as a property of individual signs or elements existing in their own right. It is rigorous because it recognizes the role of syntax in defining the rules and conditions which

govern that meaning, but views this syntax as a *syntagmatic syntax*. Unlike purely rationalized and prescriptive syntaxes which are usually single-valued, excessively analytic and have their origins in other scientific fields, syntagmatic syntax comes primarily from the problem area and usually embodies more than one descriptive tool for describing a structure. It does not argue that there will be no contradictions or anomalies within and between the images created in adopting these tools, but it takes it as its prime task to identify them and enquire into their nature and their potential for transforming the structure itself.

The issues related to this last point require a further development of syntagmatic methodology, particularly in terms of defining the appropriate descriptive theory which entails it. This constitutes the subject matter of the next chapter.

## CHAPTER 7

### ARCHITECTURAL THEORY, DESCRIPTION AND PRACTICE

#### 7.1 INTRODUCTION

This chapter is mainly concerned with bringing forward (in an extremely condensed fashion) the major arguments concerned with 'description and descriptive theories in architecture' that are contained in Appendices I and II. The aim is, first, to supplement the ideas so far evolved in the preceding chapters (particularly the last one) and, second, to establish a conceptual link between these ideas and those which are to be discussed in the rest of this thesis. Because of the summary nature of this chapter, some of its terminology and theoretical content may seem too abstract or insufficiently explained. Any difficulties which arise, however, can be reduced if direct reference is made to the original discussion in the two appendices. There the issues are dealt with at great length and further clarified by providing numerous architectural examples and identifying several practical situations to which the theoretical assumptions presently being made apply.

## 7.2 THE NATURE OF DESCRIPTIVE THEORY IN ARCHITECTURE

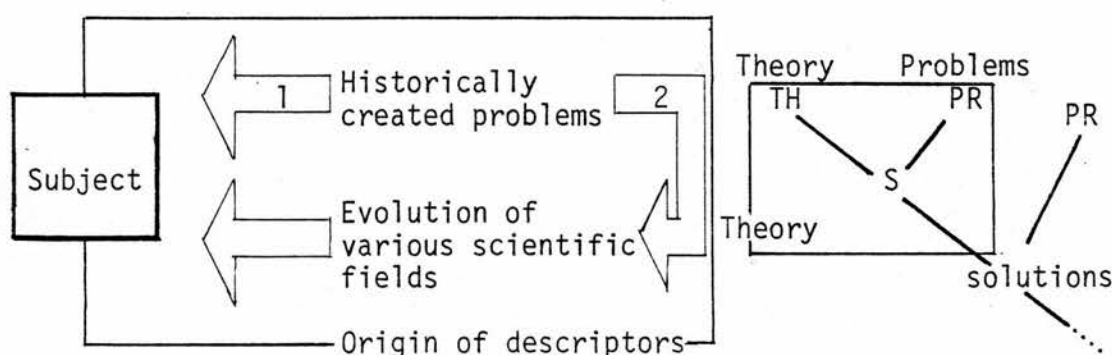
In both Appendices I and II and at various times in the preceding chapters, it has been argued that there is a conceptual level of structural investigation which relates to architecture as a science for the study of the built environment, its various object-systems and the processes by which these are produced and evaluated. The most important characteristic which such a level of consideration confers upon architecture is that it identifies the basic constitution of domain-specific architectural theory by emphasizing its ultimate dependence on architectural practice. It is in response to practice and the problems that originate in it that architectural theory proper establishes its significance, acquires its operational value, realizes its potential and discovers its limitations. And since architectural practice is fundamentally a social practice any theory which is concerned with it or the conditions of its functioning cannot but be predominantly *descriptive*.

By being descriptive is meant that the most significant task before any such theory is not a concern with attempts at universal causal explanation, but with the construction of appropriate operational links between the usually abstract and highly objectified bases of the knowledge it produces (especially when consulting other sciences), and a practice which is empirically originated and remains limited in its scope, not only by its institutionalization within certain modes of production, ideologies and so on, but also by the immediate nature of the phenomena it



deals with and the continuously changing socio-cultural and historical contexts in which they occur. In other words, the consideration of architecture as a science firmly rooted in its practice implies, as for other sciences of the artificial, that its subject matter, its stock of knowledge and its descriptive theories are historically affected.

The terms which have been used in both appendices to incorporate the above features of a theory which is taken as descriptive in architecture are: 'problem-solving capacity'; 'historical origin' (in terms of both its problems and its logical and evaluative tools); and 'comprehensiveness'. The first two terms indicate the 'beyonds' and 'behinds' of a descriptive theory, while the third (that is comprehensiveness) is



1. DIRECT ORIGIN: From historically created problems and social realization and formulation of these problems.
2. INDIRECT ORIGIN: From various scientific fields, where descriptors have been effective within analogous or quasi-analogous contexts

Fig. 7.1

mainly concerned with theory's own potential identity (such as its logical cohesion and its ability to deal simultaneously with all important aspects of the reality it describes). Significantly, it is the first two which largely attribute to descriptive theories their undeniably subjective character. This has been referred to in Appendix II (pp.346-7) by emphasizing that:

"It would have been quite ambiguous to claim that a descriptive theory which has a historical origin, a problem-solving capacity and aims at ideologically influenced purposes of the practice which it follows, might be considered under any criteria as purely 'objective'. What might be objective is exactly this realization about the subjective character of descriptive theories. Accordingly, it is quite natural to expect that the logical tools - in our case the structured analysis - which are used to analyse and even to construct such descriptive theories have to be objectified."

Within this context, two points are important:

1. To describe a reality - any kind of reality - there will be an obvious need to have a set of objectified descriptors whose substances are of necessity different; and in terms of substance, architectural descriptors may refer to substances that are as varied as to be of an institutional, environmental, activity, and so on, nature.
2. A descriptive account is never complete; being open-ended and historically originated it is only adequate for certain levels of logical complexity. This means that a certain reality can have a series of descriptions depending in the first instance on the problems (practical or conceptual) which give rise to the need for describing that reality,

the substances of the descriptors employed and the systems of social evaluation prevailing at the time. Most importantly, however, there is a need to rely on a descriptive theory whose main task is to structure all those aspects that are involved in the description including the identification of what descriptors to employ in the first place.

Initially, therefore, a descriptive theory may be defined in terms of the principle by which descriptors and their contents are brought into special (open or closed) relationship. This relationship may be referred to as the 'descriptive dimension'. Furthermore, relationships between descriptors may be examined according to the *predominancies* accorded to them by theoretical practice (at the present level of discussion this means architectural theoretical practice), where one descriptor (considered as the most important one) or a group of descriptors is, or are, accorded more predominancy than others.

The concept of *descriptive dimension* simply means that in a comprehensive and well integrated descriptive theory the various descriptors do not go their own separate ways, but stand in reflexive relationships to each other and that there is room for investigating simultaneously different aspects of a structure - such as at an activity, institutional or environmental level.

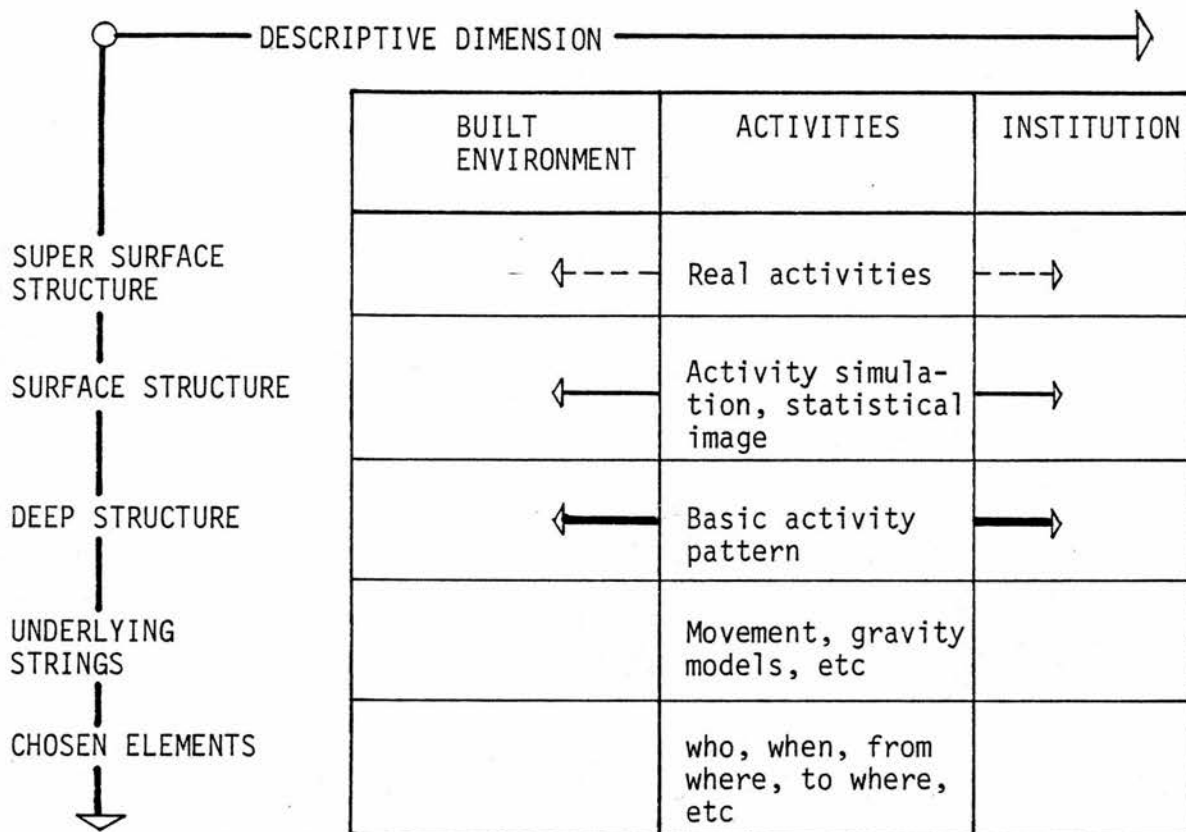


Fig. 7.2 Descriptive dimension<sup>1</sup>

The concept of descriptive dimension introduces two areas of investigation. The first is the area of the 'identity' of architectural structures, the second is the area of their 'dynamics' and 'transformational potential'.

1. The arrows on the diagram illustrate the different degrees of cohesion between the representations of the structure. The deeper levels are much easier to relate than the surface ones.

### 7.3 STRUCTURAL IDENTITY AND DESCRIPTIVE COMPREHENSIVENESS

Theoretically, the *identity* of a structure is reflected in a kind of structure of the different descriptors involved in a descriptive theory. Consequently, *comprehensiveness* emerges as one basic property of any descriptive theory. But, on the other hand, comprehensiveness cannot be acquired by combining descriptors in isolation from their historical origin, their structural context and the prevailing system(s) of social evaluation. What is implied here is that such an evaluation is *internal* in the investigation of a reality and, consequently, present in the articulation of the logical tools of a descriptive theory and especially in its descriptive dimension. This structural role of social evaluation is manifested in the construction of predominancies among the different descriptive images present in the descriptive dimension. And although it is an exaggeration to claim that the subjectivity attributed to social evaluation can continuously change the nature of the logical tools that a descriptive theory uses, on the other hand, it must be admitted that these tools express different concepts at different times and at various levels of maturity and generality. They should, therefore, without losing their abstract and generalized character, be articulated in order to include a 'contradictional' interpretation of the transformation of structures which are of specific interest for the study of the built environment.

On a specific level, each descriptor refers to a particular aspect of an architectural reality which can be identified

according to two chains; the 'complexity' chain and the 'deepness' chain. Schematically, complexity and deepness chains may be represented as follows (Fig. 7.3):

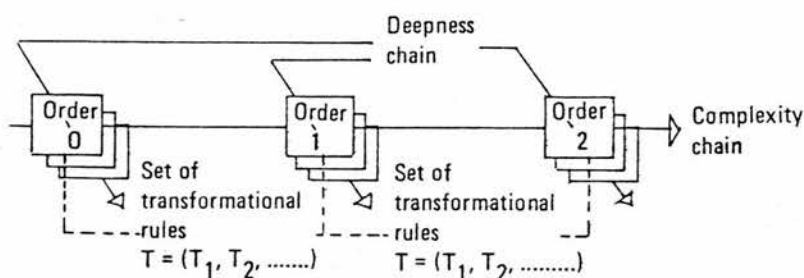


Fig. 7.3 Complexity and deepness chains (see Appendix I, p.311)

The syntactic character of the complexity chain is obviously very strong, since complexity chains are generally developed within the framework of a given substance. On the other hand, the semantic character of the deepness chain is equally strong as it connects deeper levels of the structure with its surface ones by transformational rules.

#### 7.4 CONTRADICTIONAL LOGIC, DYNAMICS AND TRANSFORMATIONAL POTENTIAL OF ARCHITECTURAL STRUCTURES

In investigating what type of syntax is appropriate for architecture, reference has been made to the linguistic analogue (Chapter 6), in order to identify both the similarities and

differences between the linguistic syntax and the 'architectural syntax' which has been characterized as being of a syntagmatic nature. The notion of *syntagmatic syntax* introduces (in an operational manner) the idea of *optimum level of abstraction* for descriptive theories of architecture which substitutes for the bipolar objectivity—subjectivity the concept of *dynamic coexistence* between a theory's abstract logical basis and the immediacy and realness of the objects of its investigation (see Fig. 7.4).

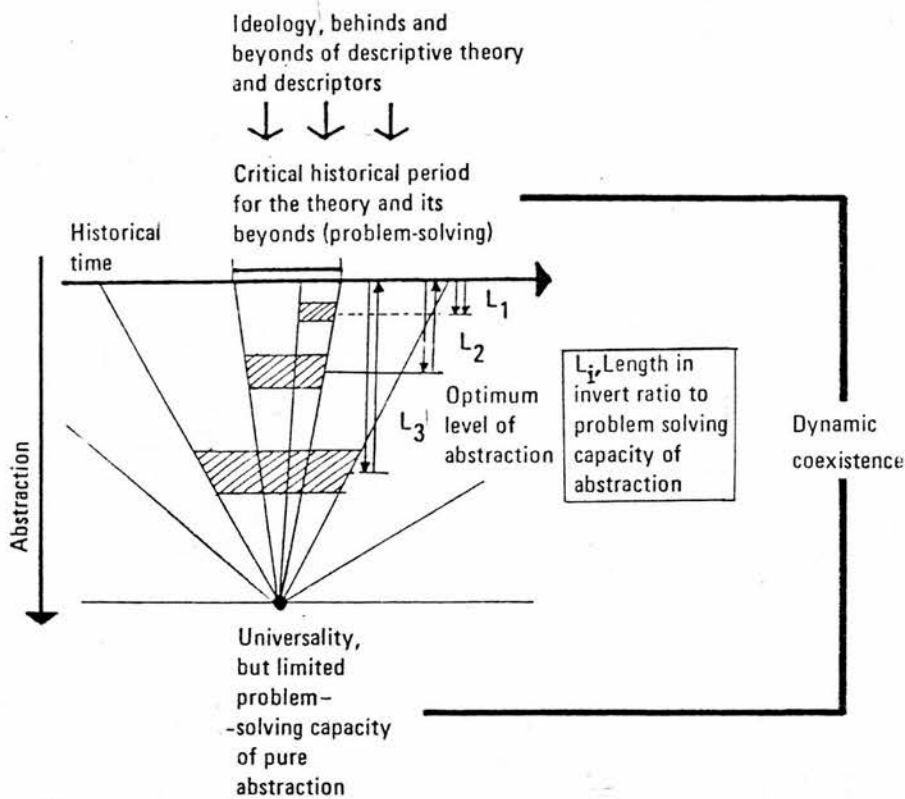


Fig. 7.4 Optimum level of abstraction and problem-solving capacity (see Appendix II, p.347)

An argument which relates to the dynamics of environmental structures, and which has been elaborated in Appendix II in terms of *syntagmatic syntax* and what has been termed as its 'contradictional logic', is that design action essentially originates in the realization of contradictions that are of a dual character. They are either what might be called 'leading' contradictions which are to be found in different forms *within* each descriptive image of a structure or 'inter-image' contradictions caused by the lack of correspondence and differentiation of substance *between* the different images of a structure. However, *leading contradictions* manifest themselves most of the time at the institutional level and, therefore, act as the major source for 'revolutionary' design action, while it is at the level of *inter-image contradictions* that 'conventional' or 'normal' design action usually originates. Because of their immediate implications for *normal design action* inter-image contradictions are more appropriately called 'normal anomalies'. Table 7.1 summarizes the characteristics of both *normal anomalies* and *leading contradictions* and evaluates them in terms of their potential for design action.



| NORMAL ANOMALIES  | LEADING CONTRADICTIONS  |
|---|---|
| a. Diachronic contradictions caused by differentiation of substance and, consequently, lack of correspondence <i>between</i> different descriptive levels of a structure.   | Present and recognizable in different forms <i>within</i> each descriptive image of a structure. More general and less circumstantial than normal anomalies.  |
| b. More objectified, since the objectivity of the descriptive theory is reflected in the ability of N.A. to represent real causes for transformation of a structure.  | More subjective and ideologically influenced since they depend heavily on the individual attitude and the general position of the architect or planner against the structure he investigates.   |
| c. High potential for transformation of a structure in terms of design action because normal anomalies, due to their nature, always suggest to a certain degree the spatial implications of their resolution (e.g. environmental-institutional, environmental-activity, and activity-institutional images). | Limited potential for transformation in terms of design action due to their ambiguity in suggesting ways for their resolution. This ambiguity stems, mainly, from their representation in very generalized form and only within one descriptive image of a structure. |
| d. Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominant descriptive images of this structure.   | Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominancies of descriptors within each descriptive image of this structure.   |

Table 7.1 Major characteristics of normal anomalies and leading contradictions and their evaluation in terms of design action

## 7.5 CONCLUSIONS

The consideration of architecture as a science firmly rooted in its practice implies that its subject matter, its stock of knowledge and also its descriptive theories are historically affected. On the other hand, what refers to the 'objectiveness' of a descriptive theory is the comprehensiveness of its logical tools. In this context, comprehensiveness is interpreted as the ability of a descriptive theory to deal simultaneously with different images of the reality it attempts to describe. Comprehensiveness, however, cannot be acquired by combining descriptors in isolation from both their historical origin, their structural context and the prevailing system(s) of social evaluation.

In addition, there is the view that a contradictory logic necessitated by the involvement of the descriptive dimension and incorporated within the methodological framework of the syntagmatic approach becomes a useful dialectic for studying the identity, dynamics and transformations of architectural structures, and contributes to the descriptive theories concerned with them. There is also the view that the potential of conventional or normal design action is largely limited to the resolution of immediate problems identifiable at the level of normal anomalies. Normal anomalies are inter-image contradictions originating in the lack of correspondence between the different images of a built environment structure mainly due to the differentiation of substance of the descriptors which reflect

those images.

When considered simultaneously, normal anomalies generate a high potential for transformation of the structure as a whole. They do so irrespective of the level of complexity or deepness at which a structure is viewed, but most significantly at the level of its syntagmatic syntax. The syntagmatic language, as has been repeatedly argued (see Chapter 6, especially), is the language of prototypes in architecture; and it is the study of prototypes which it is hoped will provide the conceptual unity between architectural theory and the practice of its design. The remaining chapters of this thesis are mainly devoted to this objective.

## PART III

### CHAPTER 8

DESIGN AND PROTOTYPE: THE NEW CONCEPTION OF THE DESIGN  
PROCESS IN ARCHITECTURE

### CHAPTER 9

THE IDEA OF THE ARCHITECTURAL PROTOTYPE AND TWO AREAS OF  
RESEARCH AND DEVELOPMENT

## CHAPTER 8

### DESIGN AND PROTOTYPE: THE NEW CONCEPTION OF THE DESIGN PROCESS IN ARCHITECTURE

#### 8.1 INTRODUCTION

This chapter and the following one elaborate the discussion on the notion of the architectural prototype and explore its potential at two levels; a) as a design tool, and b) as a research tool - drawing both on the conclusions reached above and those which emerge below. This chapter investigates the idea of the prototype in conjunction with a series of similar notions advanced in the literature, and mainly within a design-theoretic context. The next chapter argues the case for two areas of research: the 'prototypic analysis' of the built environment and the development of 'design-specific' prototypes.

#### 8.2 THE IDEA OF PROTOTYPE IN A DESIGN-THEORETIC CONTEXT

Central to the nature of architectural prototypes is a discussion of the design process in architecture and of its pre-structured/prototypic origin. Emergent views on the design process, developed over this decade, represent a decisive shift from previous rationalized thinking about how design *is to be done* and to become a precise instance of the *optimal*, to concern over

how design *is actually done* and is an instance of the *prestructured*, the *prototypic* and the *possible*. Most design theorists now agree that design action is fundamentally founded in an elaborate process of transformation and reciprocation between a pre-existing knowledge field which owes much of its synthetic existence to past solutions, experience, beliefs and so on, and a set of contextual constraints imposed by the particular design problem at hand and the information concerned with it. There are many approaches with this orientation in the recent literature, but the few contributions discussed below provide sufficient evidence to support the argument.

Drawing on the ideas of Kuhn (1970) and Polanyi<sup>1</sup> about the nature of knowledge (*tacit* and *explicit*) and its sociology, Raman (1977)<sup>2</sup> argues the case for the 'tacit dimension' in design by emphasizing that:

"The process of design in architecture, like any other human activity, is not sustained entirely by totally objective knowledge. Inherent in all architectural solutions are a number of factors which can neither be described as belonging to logic nor as expressive of a concern for the requirements of those who use buildings. They are to do with architects' beliefs, values, 'ways of seeing', and so on. But they should not be regarded as defects or idiosyncracies peculiar to certain groups of architects. On the contrary, these factors are essential to the spirit of architectural vocation." (Raman, p.855).

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1. For a book summarizing Polanyi's central views and founding them on the concept of meaning, see Polanyi (1975). Both Polanyi and Kuhn agree that no knowledge is or can be wholly explicit. More significantly, implicit knowledge, scientific or otherwise, is essentially acquired by the act of doing (that is in its practice) rather than by simply acquiring rules about it and memorizing them in idle.
  2. Further details of Raman's argument can be followed in his 1976 Ph.D. thesis entitled: *Information and Architectural Design*, Edinburgh University, where numerous historical examples and biographical accounts of the approach to design of some prominent architects are cited.

The most important conclusion Raman deduces, however, is that the major part of designers' work rarely aims at producing unprecedented design ideas *as such*, and yet designing cannot be said to proceed by a simple replication of established prototypical solutions. Nevertheless, "once an architectural idea comes into existence it is possible to recognise the characteristics that relate it to the historically emergent prototype or model." (Raman, p.857).

In a similar but antecedent approach, Hillier et al (1972) make a significant contribution to the debate on the process of architectural design on two fronts; first, by convincingly challenging the epistemological basis of the Systematic Design Methods Movement (SDMM) and, secondly, by rejecting its call for the elimination of designers' preconceptions before embarking on the act of designing. Instead, the authors confirm the primacy of these preconceptions and explore their relevance within the context of what they generally characterize as 'prestructures'; the important question being, "not whether design action is pre-structured but how it is prestructured, and whether the designer is prepared to make this prestructuring the object of his critical attention." (p.12).

Most importantly, Hillier et al identify four areas in what they call the 'designer's field' to which research could contribute, namely the areas of *instrumental sets*, *solution types*, *codes* and *information*. The kind of research appropriate to each of these areas is characterized as follows (pp.18-9):

1. Much research of the purely technological kind has its outcomes in terms of instrumental sets.
2. Development work extends this into solution types by providing exemplars.
3. Research which aims to provide a method of checking design proposals against abstract requirements can be seen as a partial formalization of codes (partial because it is concerned with testing rather than generation and it is piecemeal).
4. Research which has its outcomes in the form of 'results', rather than a tool, falls into the field of information.

The authors conclude that of the four areas open to research, it is the second area and its possible outcome in terms of exemplars and prototypes which holds the highest likelihood of influencing designers at the crucial stage of initiating a design solution. Nevertheless, because of the restricted definition they apparently hold about prototype or solution type (as something nearly open to exact replication) and consequently the likely dangers they associate with the results of this area of research<sup>3</sup>, the authors feel somehow obliged to recommend the priority of the second most influential area of research - that is the area of codes, mentioned in the third category of the above list.

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3. *Such as that designers might adopt these results in an imitative way, or if the development of the prototype is inadequate it may lead to the proliferation of these inadequacies or that the prototype may be poorly understood or badly adapted. Dangers of this kind, however, cannot really be limited to the results of research on prototypes. The results of research in any area are and can be open to misguided application, proliferation of inadequacies, poor understanding and bad adaptation. The important point to note here is that design which proceeds by pure imitation must be a contradiction in terms.*



The notion of *codes* is, of course, what has since been at the base of Hillier and Leaman's theoretical investigations, but whose concrete articulation still remains largely at the level of syntax, especially in the form of the 'space syntax model'<sup>4</sup>. However, from the point of view of this thesis, it is the idea of solution type or prototype which deserves more articulation. If prototype is considered at the higher level and in the pragmatic manner which has been envisaged in the preceding chapters, then it must be able to allow for a concept such as that of codes and its variants to operate in conjunction with it as it also did the notions of image, schema and syntagm. Indeed, despite their obvious reservation, Hillier et al (1972, p.19; see also Hillier, 1972; Hillier and Leaman, 1974a) themselves say that the advantages associated with the development model (that is of prototype or solution type) should not obscure its potential usefulness. They argue that it could provide an organizational solution to the problem of linking research effectively to design.

"If research workers work with designers in producing experimental prototype solutions, which are intensively monitored and improved, then explained and publicised, then research itself benefits by becoming part of a dynamic process from which it can continuously learn and develop its concepts." (Hillier et al, p.19).

A productive situation would be one in which a development team is provided with a properly developed monitoring system which is closely linked to a building programme.

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4. For review, refer to Section 3.3.

An approach which is supportive to the argument of giving priority to research on prototypes has also been developed by March (1976).

"If the design process is externalised and made public, as it evidently must be, for team work to be fully effective, ... [then] in this externalised process it is feasible to experiment with artificial evolution within the design laboratory using simulated designs and environments. New synthetically derived stereotypes<sup>5</sup> may emerge, and old ones may be given new potential without having to wait for practical exemplification. Design comes to depend less on a single occasion of inspiration, more on an evolutionary history..."  
(March, 1976, pp.21-2)

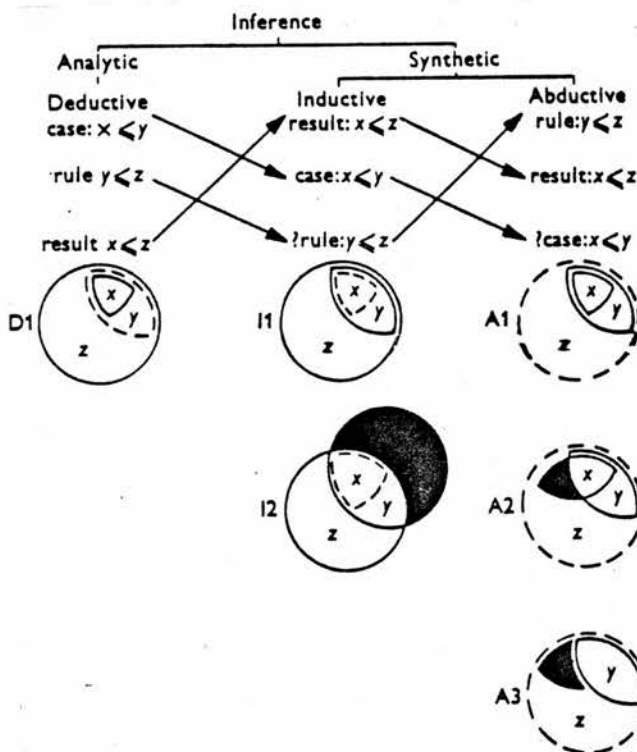
To advance his thesis on the design process, March draws on the classification of logical inference argued in the philosophy of C.S. Peirce, where synthetic modes of reasoning are given logical priority over *explicative* (or analytic/deductive) ones. According to Fann (1970)<sup>6</sup>, Peirce's original contribution is exemplified in that, unlike both past and contemporary logicians and philosophers of science whose interest has so far largely centred on describing how one sets out reasons in support of a scientific hypothesis once proposed (by then the hypothesis would have already been a *finished product*), Peirce was more concerned with the logically prior and more important question of how to characterize the *conceptual context*, within which any such hypothesis initially comes into being and gets adopted. And to this his *theory of abduction* was devoted.

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5. As in the sense prototype, solution type and so on are used. See also Section 8.3 below.

6. Fann's (1970) book is entirely devoted to the systematic extrapolation and explication of Peirce's theory of abduction as it has been disseminated throughout the eight volumes of his Collected Papers. Part of Fann's extrapolations referred to here is attributed by him to Hanson (1959).

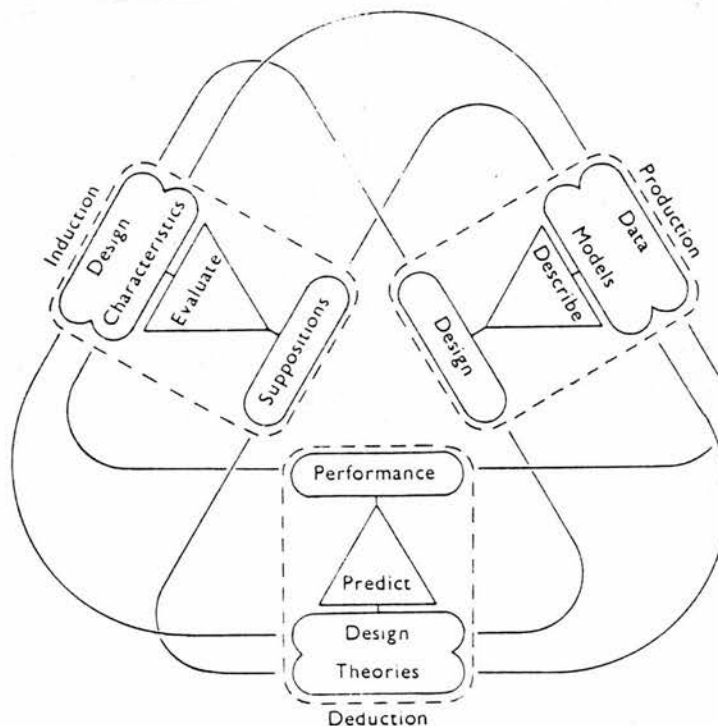
In Peircean philosophy, *abduction* and *induction* are the two components of *synthetic* reasoning, but within this, abduction is the one which is logically prior and more productive, though its determinate certainty is comparatively low as one progressively proceeds towards induction and deduction, respectively. Abductive inference, of which one is rarely wholly aware, crucially determines the nature of the thought contents of which one is or is to be factually aware. And for March, that is typically in the nature of initiating any design proposal.



Peirce's three modes of inference. There is one form of analytic reasoning, the deductive, shown in D1 as logically determined. There are two forms of synthetic reasoning, the inductive and the productive. The hope in inductive reasoning is to arrive at the conclusion shown in I1. However, there is no logical necessity for this and the typical outcome must look like I2 where the black part of  $y$  indicates the amount by which the rule  $y \leq z$  is not met. Abductive reasoning has three distinct possibilities. In A1, as in the ideal world of Sherlock Holmes, the motive (rule) and the evidence (results) conspire 'beyond all reasonable doubt' – but without logical certainty – to prove the accused guilty (case). In A2, more typically, there is a shadow of doubt marked by the black part of  $x$  suggesting the degree by which  $x \leq y$  is not supported. A3 is yet another possibility. Here the evidence and the motive simply do not tie up:  $x$ , the black zone, is disjoint from  $y$ .

Fig. 8.1 (According to March, 1976, p.17)

March gives equal priority to synthetic reasoning in design, but replaces the term abduction with that of *production* which carries its creative implications in a design sense. He relates inductive reasoning to *evaluation* and productive reasoning to *analogy*. The former refers to the logic of accepting a design proposal as of sufficient adequacy, while the latter to the logic which makes the suggestion of any one design proposal possible in the first place. March then comes to conceive of rational designing as being constituted by the trilogy production/deduction/induction (PDI), where (paraphrasing Peirce) "production creates; deduction predicts; induction evaluates." (March, p.18). The PDI-model of design is schematized as follows (Fig. 8.2):



The PDI (production/deduction/induction)-model of the rational design process described in the text. The diagram suggests a cyclic, iterative procedure PDIPDIPD... and so on, with constant refinements and redefinitions being made of characteristics, design and suppositions as the composition evolves. In fact the model is envisaged as representing a critical, learning process in that statements inferred at later stages may be used to modify those used in earlier stages and thus to stimulate other paths of exploration. For this reason no arrows are shown along these paths, although the general direction of argument is clockwise.

Fig. 8.2 (According to March, 1976, p.20)

In the course of his discussion, however, March makes two highly significant contributions in which this thesis finds support. The first is the emphasis he places on the explicit treatment of the question of value in design. The second is the demonstration of how productive reasoning (or synthetic reasoning generally) in the design process gets facilitated in terms of such notions as the 'building type' or (borrowing a term from Hawkes, 1976) the 'stereotype' which can be easily linked to the idea of the 'prototype'.

March insists that the act of designing is the act of evaluation and to separate design from value is to force a distinction on design practice which does not and cannot exist. What are and are not good reasons for adopting a design proposal are for the most part questions of value and not a matter of undisputable fact<sup>7</sup>. This makes March's approach consistent with the syntagmatic framework which has been proposed in this thesis<sup>8</sup>. This becomes especially true, when he proceeds to incorporate within his approach the concept of *building type* or Hawkes' notion of the *stereotype*.

### 8.3 PROTOTYPE, STEREOTYPE, FORMAT, PATTERN LANGUAGE, TYPE-CASTING, DESIGN SCHEMA AND OTHER DESIGN-THEORETIC NOTIONS

Hawkes (1976) associates the notion of *stereotype* with that of a popular solution (in the sense of it being widely recognized,

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7. *For further exploration of the question of value and evaluation in design, see March (1976). See also Simon (1975), for a conception of 'Style' as an act of evaluation and choice among alternatives.*
  8. *This can be extended to cover also the research on configurational studies which has been reviewed in Section 3.5.1.*

understood and found successful) which finds its first development within the confines of a particular building type, but which remains open to generalization, thus offering a convenient start for the solution of some recurrent building design problem.

"In this context, it is simply that there is, at any point in time, a generally held notion about the nature of a good solution to any recurrent building design problem and that it is this notion which frequently inspires the initial design hypothesis."  
(Hawkes, p.465-6).

In fact, there is no stopping the generalization of any aspect (for instance, environmental) of a successful stereotype to solve problems of other building types. In this respect, it is interesting to note that the idea that a particular building type may provide adequate solutions to problems of design of wider generality than merely those of its particular kind has been suggested almost forty years ago by the Czech semiotician Mukarovsky in a paper entitled *On the Problem of Functions in Architecture*<sup>9</sup>.

Mukarovsky argues that every period in architecture seems to have a dominant building type with regard to which it solves some of its basic problems - say, those of construction. A clear example is the cathedral in Gothic architecture. One reason why any building type may operate in such a manner is the fact that the functionality of any particular building type is never something quite separate from the functionality of all others. The individual types do not lack in interrelations, mutual influences or overlappings whether these refer to activities, economies,

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9. This paper is now included in Mukarovsky (1978).

internal environments, technologies and so forth. The reason for this lies in the nature of architecture itself, since architecture relates to man in his entirety and always has to be adaptive to his changing needs.

"The potential relation of architecture to *all* man's needs and aims is vividly illustrated by the possibility of a shift in the dominant function of an architectural creation (cf. the use of a palace as an official building or a stock exchange as a university building) and by the possibility of a shift in the dominant function of an entire architectural *type* (cf. the evolution of a type of basilica from a commercial into a religious building)."

(Mukarovsky, p.241, his emphasis).

Hawkes' idea of stereotype is, in fact, only one variant of a series of similar notions which are spread widely in the literature and all of which pertain to the concept of the architectural prototype as has been generally presented in this thesis. Hillier et al's (1972) inclusion of the notion of 'solution type' as a component of design 'prestructures' has already been mentioned in this chapter. Other concepts include Alexander et al's (1967; 1968; 1977) 'pattern language', Allsopp's (1977) 'format', Lerup's (1977) 'type-casting' and as early as 1963 Norberg-Schulz' idea of 'design schema' (which incidentally antedates the full flourish of the SDMM).

Historically, concepts of this type are by no means new to the theory and practice of architecture. The conception of *pattern books* may be cited as a clear embodiment of similar ideas, and also, as identified in a well documented essay by Rykwert (1972), the idea of the first prototype - the 'first house' (that



is the 'primitive hut') - which though lost in pre-history, still has influenced architectural theorizing (both folk and professional) through countless written, verbal or drawn accounts from many cultures involving religion, philosophy, myth, politics and so on. The persistent return to this idea by writers on architecture from Vitruvius to the present day and also by practically all peoples at all times, says Rykwert (p.183), has always represented a return by architecture to its supposedly real origin in the hope of recovering the original form and essentials of all building, and, more significantly, in search of renewal or inspiration and as a guide to a rational way out of its recurrent crises.

It is evident now that the group of concepts which have been discussed above and their variants are already engaged, in one way or another, in a similarly important task, not only with reshaping architectural theory and practice generally, but also with regard to reorientating individual approaches. It is sufficient to refer to the gradual but steady reorientation in the ideas<sup>10</sup> of a design theorist of Alexander's stature to see this crucial role in operation.

Alexander now accepts that design action does not necessarily start from the abstract level of so-called *needs*, but that there is a level (that of *patterns*) in which both forms and contents, problems and solutions coexist, and, therefore, can be investigated on a multi-descriptive basis, and function as nuclei of complex

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10. *As they now culminate in the trilogy: The Timeless Way of Building; A Pattern Language; The Oregon Experiment.*



environmental structures. Most importantly, he accepts that the discovery of these patterns does not follow from strictly stated formal procedures (of the kind, for instance, he identified in *Notes on the Synthesis of Form*), but, in fact, are informally accessible to all who are concerned with the artificial environment, be they designers or users. Furthermore, he accepts that the realization of these patterns in the real world is not a matter which is exclusively subject to technical means, but is fundamentally decided by socio-cultural forces. In other words, design is and always has been part of a larger socio-cultural framework and thus cannot be thought of as totally autonomous and self-justifying in its own terms. It is on these counts that the syntagmatic approach may find support in Alexander's present efforts to reformulate a theory which is located much nearer to the level of design practice.

#### 8.4 CONCLUSIONS

The examples which have been discussed of design-theoretic notions and their close relation to the idea of prototype could be extended, but the point has been made. There is little in the arguments which have been advanced in their support which contradicts the concept of prototype as envisaged in this thesis or the syntagmatic structural approach suggested for its investigation. In the various approaches, there emerges a keen attempt to re-equip architectural theory with the most fundamental tool by which architecture has always presented itself, both to its design

practitioners and its users. The image of the designer as a detached objective form-giver, entirely dependent on abstract formulae and dicta and operating outside history, society and value is seen to be unrealistic. What they represent is a set of integrative concepts capable of spanning the gap between the theory of architecture and its practice, between its ends and means, between its problems and solutions and, above all, between its design practitioners and users. But the design process itself remains just as open-ended as it has always been and its products remain subject to transformation and elaboration in use throughout their lives.

## CHAPTER 9

## THE IDEA OF THE ARCHITECTURAL PROTOTYPE AND TWO AREAS OF RESEARCH AND DEVELOPMENT

## 9.1 INTRODUCTION

The discussion in the preceding chapter suggests two major areas of research on architectural prototypes. The first is concerned with investigating the prototypic potential of the built environment itself and is called 'prototypic analysis'. The second is the development of 'design-specific' prototypes. Here new prototypes are to be proposed and analysed, and their problem-solving capacity (going beyond *one-off* solutions) in response to certain problem-fields in design is evaluated. To this area of research, this thesis offers a preliminary working example which is presented in Part IV, Chapter 10.

The two areas of research are, of course, interconnected in terms of the methodological tools they both require and also in terms of the contribution they make to the stock of architectural knowledge - especially within an operational design-theoretic context. Furthermore, the results of the first can always provide a source in which many of the proposals made by the second are to be originated. Within the scope of this thesis, however, the discussion emphasizes the general significance of the two areas, and not the exact details of how they are to be conducted.

## 9.2 THE PROTOTYPIC ANALYSIS OF THE BUILT ENVIRONMENT

From the outset, there seems to be an advantageous situation for architectural knowledge to exploit. That is, however implicit this knowledge is said to be, it remains open to interaction with a subject matter whose general plasticity is comparatively high. The idea here is that the process of internalization of knowledge about, say, a prototype, whether by individuals or groups, may, to a considerable degree, be subjected to a conscious process of critical externalization, and thus made public and communal. This is especially so if the prototype in question has already found a degree of substantial realization in the form of concrete objects such as buildings. To draw the attention to this possibility, however, is not to argue that prototypes as such coincide exactly with material objects such as buildings or elements of them. A prototype is always less than the full materiality of any one particular object, but, on the other hand, always more than it in terms of its generality.

Nevertheless, there is an important sense in which actual objects or artefacts enter into the definition and identification of prototypes. Like any other real-world phenomenon, a building embodies both its empirical reality and, epistemologically speaking, an underlying structure which can be conceived of at various hierarchic levels of abstraction, and which it shares with more than one other building. It is at those hierarchic levels that prototypes inhere. But, as there can be no language without speech, it is the actual buildings which ultimately provide evidence for

the existence of these prototypes, or alternatively substantiate their operational validity and offer them points of contact with everyday architectural reality. This has been confirmed in Section 6.4 (p.168) when arguing that, "[prototypes] are not surface phenomena in themselves, yet not entirely isolated from the rich level of observables, since they realize their potential and material existence in it. Prototypes are understood only because they are already *virtually* contained within the architectural environment."<sup>1</sup>

Indeed, since every architectural artefact somehow conceptually originates in a constitutive prototype or set of prototypes, it in turn becomes inexhaustibly latent with prototypes in which new designs can also originate, and which in turn provide extra sources for further designs, and so on *ad infinitum*. In this continuous evolution<sup>2</sup>, architectural design transforms into prototype(s) every architectural product it encounters. To design is largely to conceive and make available to oneself the entire built environment as a prototypic apparatus.

The prototypic contribution made by the built environment itself, therefore, must be part of the object of investigation of any comprehensive theory which is associated with its design. The particular type of analysis concerned with extrapolating prototypes from the built environment itself or describing it under a prototypic profile is termed here 'prototypic analysis'. In terms

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1. See Section 6.4, for further elaboration

2. This does not mean that as they evolve, prototypes necessarily transform into better ones. Prototypes do evolve all the time, but like buildings, they also remain open to degeneration, obsolescence and so forth.

of the argument advanced in this thesis (especially in Part II), this analysis is, of course, structural. It is best conducted at the level of examining systematically the evolutionary character of these prototypes within the general framework of the syntagmatic approach, its descriptive contradictional logic and its operation within the limits of social evaluation and the predominancies it gives to particular aspects over the others.

### 9.3 THE HISTORICAL DIMENSION AND PROBLEM-SOLVING CAPACITY

Within the context of a syntagmatic approach, any attempt to investigate a prototype is bound to open up a hypothetico-historical investigation about the prototype. It is simply that, however novel or radical a prototype is, no prototype really has a separate existence of its own. Any prototype new or old is nothing but a node in a network of prototypes. Emergent prototypes always somehow embody several characteristics of earlier prototypes and at the same time extend some of theirs to future emerging ones. And that can also be shown to be true of design action itself.

Just as for a design proposal, when we conjure a prototype, we formulate some tentative belief about it, a belief which results in giving it a 'generic centre', of referring it to a moment of 'presence' or 'origin'. This generic centre founds and constitutes its elementary structure. But then one must subject

this structure to an analysis which is critical and stress its open-endedness. There is no absolute fixity to the meaning of this structure, since we have to admit that much of the meaning is socially appropriated and amplified, and, therefore, has to be coordinated with some historical relevance. Thus the emphasis in page 168 that:

"[Prototypes] presuppose a structural organization that is relatively persistent and amenable to some form of analytic treatment, yet they retain a property of fundamental incompleteness that makes them flexible, dynamic and open to transformation and hierarchic permutation. They continuously negate their actuality only to re-introduce it enriched with new possibilities that obtain within various operational contexts. Hence they can be employed creatively in the process of producing new architectural realities as yet non-existent, and, therefore, linking existent and past realities to possible and future ones, but which can only be grasped within historical limits and which are constrained by culturally emergent conditions of usage."

In terms of prototypic analysis, the historical interpretation called for here is not a matter of definitive causal explanation or mere chronological ordering. It is mainly to do with problem-solving, and can be approached in a manner which is conjectural; and which, therefore, remains open to variation and further improvement. It best proceeds by conjuring a field of historically emergent problem situations to the adequate solution of which a prototype or set of prototypes had or could have contributed, within the constraints of certain systems of social evaluation and the availability of the descriptive tools associated with them. It is within the context of such structured situations, and the variations in them, that the historical relevance of past prototypes

to present-day problems can be assessed and maximized. And this is where prototypic analysis could strongly link to research on 'design-specific' prototypes, since it is one of the most convenient and perhaps most productive activities of the latter is to develop and take advantage of the positive results of the former.

#### 9.4 SPACE, FORM AND PROTOTYPE

Part I has characterized the differentiation of space for human habitation as the most important function and immediate result of architectural actions. Consequently, the most elementary structure that is to be recognized as architectural must be dependent on a high measure of spatiality. Inherent in such a view is the importance of spatial dimension to apprehending and defining an architectural prototype. In other words, all spatial forms are potentially pregnant with architectural prototypes. But there are two major types of spatial forms which architectural prototypes could inhabit; *planar* (as when the concern is limited to layouts or what has to do with surfaces generally<sup>3</sup>) and *nonplanar* or *volumetric* (as when prototypes are assigned to forms which are at least minimally habitable by humans and sufficiently complex to support an empirical content which goes beyond hardware and statics viability<sup>4</sup> and provides for necessary environmental conditions

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3. *Particularly in aesthetic terms.*

4. *When receiving the attributes of a solid which allows for the containment of a building fabric and structural resistance to such forces as gravitation, wind and so on.*



which admit to a variety of activity programmes). Obviously, the ability to inhabit a physically viable volumetric form, but one which is not severely constrained, should prove a productive attribute (particularly in terms of design-specific prototypes). It is the one which is more true to the nature of architecture and capable of referring to it as a totality.

However, whatever type of spatial form a prototype may take possession of, it must be noted that it is not the study of forms *qua* forms which is the essence of either prototypic analysis or the development of design-specific prototypes. The apprehension of any form requires a structure which goes beyond a single abstraction of it in order to cover such vital matters as specifying a topology appropriate to its definition and identification, conferring on it a content and assigning to it the conditions which constrain and make possible its social use. Once again, this thesis emphasizes a conception of this structure as being evolved within the syntagmatic framework, especially when it comes to conceiving of any form as prototypically architectural. To all this, of course, the concept of the architectural function is central.

Now, whatever criticism one may levy against *Functionalism* as a philosophy in architecture, the concept of function itself loses none of its importance insofar as it means the variety of purposes which architecture serves in society. A helpful functional distinction has been proposed by Hillier et al (1972; see also Hillier, 1972; Hillier and Leaman, 1974a) in terms of their

'four-function model' which conceives of building as: (i) a climatic modifier; (ii) a behaviour modifier; (iii) a resource modifier; (iv) a symbolic modifier. These are, of course, not exhaustive, but, as the authors point out, they seem to be the ones which have historically dominated the bulk of buildings. Besides being interconnected, each function presupposes a multidisciplinary framework to deal with it, while suggesting a way of mediating the relationship between people and environment and between people and people simultaneously. It refers to building in its totality and not just parts of it.

Collectively, these four functions constitute a useful set upon which research on prototypes could perhaps initially concentrate. The architectural viability and design operationality of a prototype which satisfactorily incorporates these functions will no doubt be obvious, <sup>will</sup> as also its 'syntagmaticity'. And since the results of this type of research are not expected to be tied to single instances of consideration or fixed prototypic assemblies, but to develop on an evolutionary basis, then, it should be possible to introduce a time dimension where the change-rate in performing these functions could be monitored before any set of, say, design-specific prototypes is made available for purpose of wide-scale applications. At any rate, the way these prototypes should be developed must be in a manner which is inviting to designers to modify and elaborate on them and not face them with a situation which allows no room for manoeuvre or participation. There is always that element which to some degree differentiates

each design problem from every other (if only in terms of location). This differentiating element, of course, does not necessarily make the design problem entirely unique, but, nonetheless, it is the one which constitutes its specificity. Therefore, any design tool which is required to apply to more than one problem-situation cannot remain rigid. It must be able to transform under constraint. And that is probably what is so important to design itself; to effect a transformation on a constrained situation.

## 9.5 CONCLUSIONS

This chapter argued the case for research on the *prototypic analysis of the built environment* and the development of *design-specific prototypes*. These two areas of research are expected to make a valuable contribution to the growth of operational architectural knowledge, particularly within a design-theoretic context. The operational modalities of either type of research, however, have not yet been worked out in detail; consequently, there emerges a potential field for further investigation. But, whatever the results of this effort, the concept of prototype itself remains an operational one, the main intent of which is to operate as a bridge between theory and practice, with a view on characterizing general fields of solution/problem situations.

In the same way as the concept of structure has been approached, it is not the attempt to try and pinpoint a definition of the word prototype which constitutes its utility, but rather the sense of being able to develop an idea of it operationally and relate it to design-theoretic contexts. Prototypes, like structures, can be envisaged as deep constitutive formations, but they are never permanent or fixed: they are continuously being evolved and transformed at different stages in history and in response to emerging fields of problem-situations. Just as for any structural whole (as has been discussed in Chapter 5), a prototype is capable of contracting an indeterminate number of elements whose relationships cannot merely be ordered in a linear fashion or by inherent or absolute qualities, but only by their place in its organisation.

The advantages of the union of conceptually and potentially material contexts with a recognizably prototypic apparatus through the establishment of a guiding methodological framework (here proposed as the structural syntagmatic framework) make the joint study of such important concepts as spatial form and structure, and their operationalization within limitations of architectural functions, an extremely beneficial field of enquiry for architecture. This, obviously, is a long-term project to which a substantial share of research effort may need to be directed, but the working example given in the following part is intended as an illustration of its potential. This example is not yet a fully developed prototype, but it represents the start of a promising one.

## PART IV

### CHAPTER 10

#### TOWARD A DESIGN-SPECIFIC PROTOTYPE: A WORKED EXAMPLE

## CHAPTER 10

### TOWARD A DESIGN-SPECIFIC PROTOTYPE: A WORKED EXAMPLE

#### 10.1 INTRODUCTION

This chapter offers an illustrative example of the possibility of developing a design-specific prototype which might lend itself to a wide range of architectural applications. Historically, the prototype has its origin in a school design project developed by the author as an undergraduate student at the Department of Architecture, University of Khartoum. The general solution arrived at was based on a standard 'prototypic unit' and was elaborated on a multiple hexagonal grid. A few representative drawings of this were deposited with UNESCO's Regional School Building Centre for Africa<sup>1</sup> and were documented in its newsletter of summer, 1967. Two of these drawings are included here as Fig. 10.1.

Until very recently, however, the underlying idea remained in its original elementary form, despite its obvious potential for further development. It is now in response to this thesis' advocacy for research to develop a vocabulary of design-specific prototypes that the opportunity has been taken to start the process of realizing that potential. It has become apparent that the basic idea can be generalized in various ways which are more productive

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1. *The Centre's Headquarters were then in Khartoum, Sudan.*

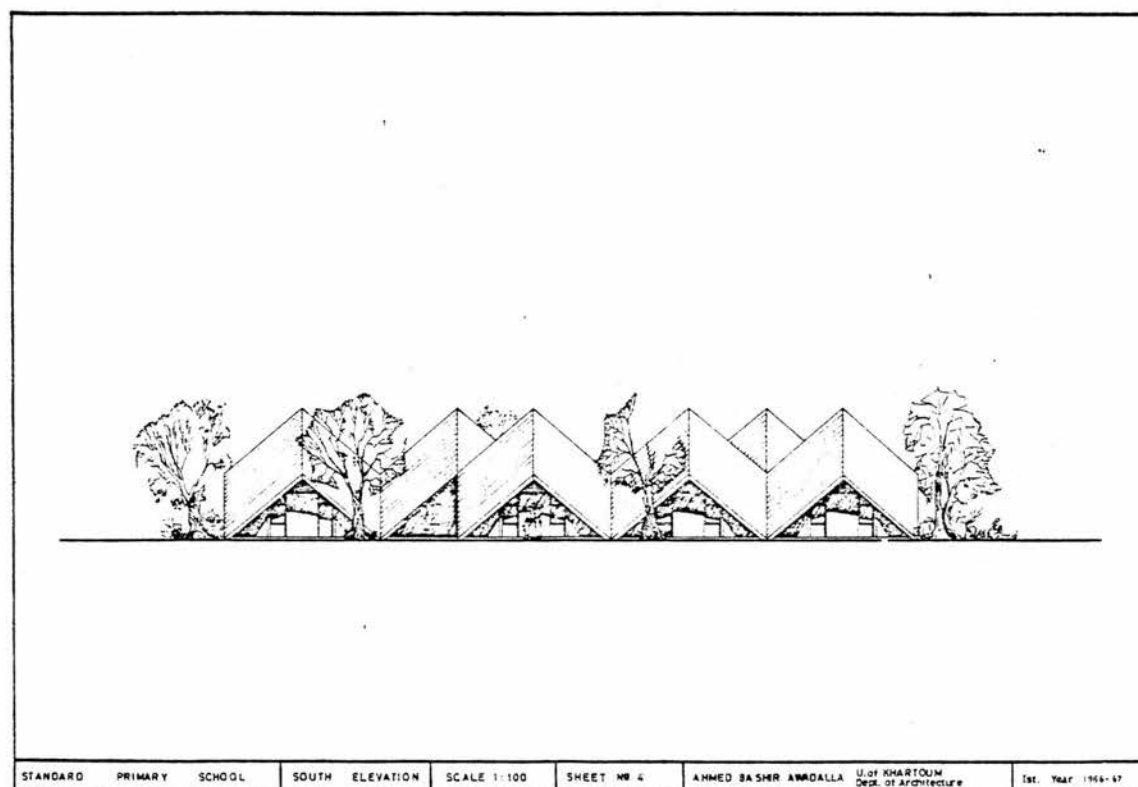
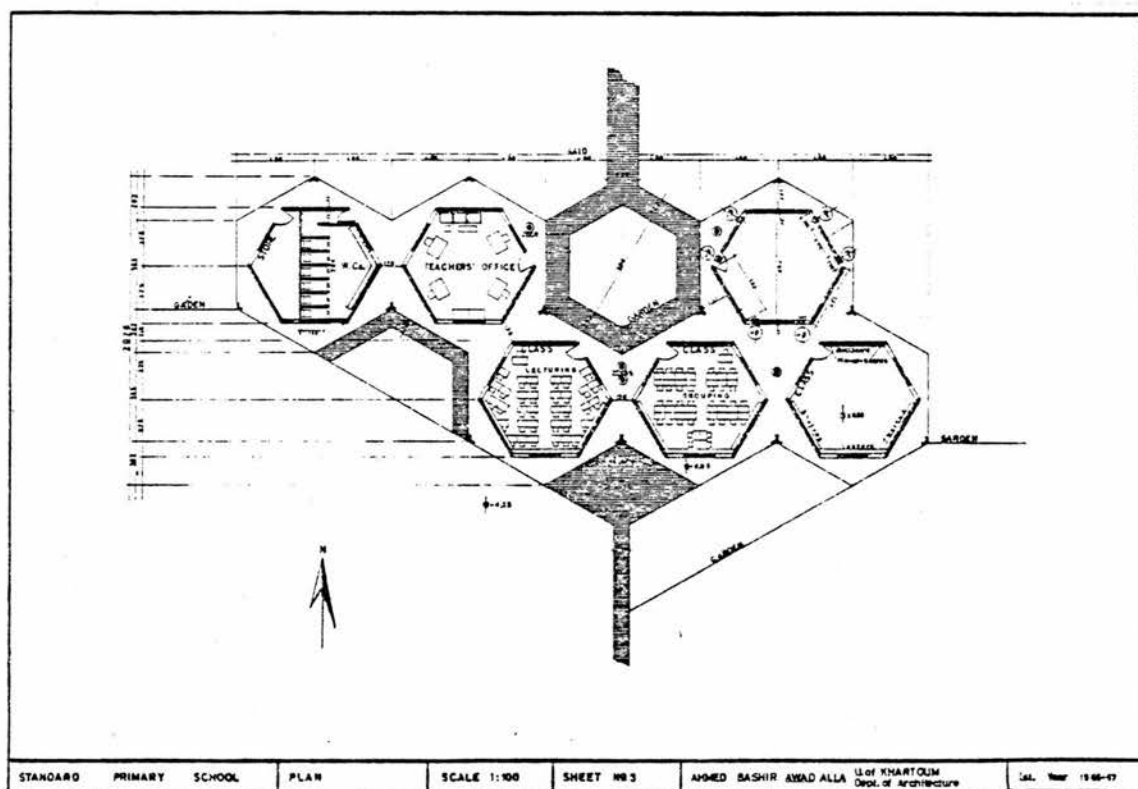


Fig. 10.1

than the one in which it was originally proposed. The results have proved too numerous to include completely in this chapter and what is represented here remains only a limited sample<sup>2</sup>.

The spatial form which this prototype initially inhabits is polyhedral, convex, flat-faced and single space-filling, but it also admits of combination and juxtaposition with several other well-known geometrical solids, including the two Platonic figures, the *cube* and the *tetrahedron*. More significantly, this 'prototypic polyhedron' is found to be a sub-member of a new 'parent' group of singly space-filling polyhedra, independently identified and characterized by the author, and given the generic name 'CUBO-DODECAHEDRA'<sup>3</sup>.

Because of the powerful constraints space imposes on any structure which inhabits it, it has been decided, within the confines of this chapter and limitations of PhD research, to lay greater emphasis on exposing the geometrical aspects of the *prototypic polyhedron*, particularly those which relate to its spatial transformability. The aim is to achieve a first level of intelligibility which can easily be appreciated by both design theorists and practitioners. Geometrical descriptors have the important benefit of being general and less circumstantial. They

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2. For an earlier exposition of many of the results included here, see Awadalla (1978).
  3. In Section 10.4 it will be shown that what has been called here the *prototypic polyhedron* is, in fact, half a 'standard cubo-dodecahedron'. However, for convenience, the term *prototypic polyhedron* will be commonly used throughout the discussion.



consist of highly objectified concepts which, once established, become commonly agreed upon and less open to dispute. It is also in their nature to be mainly concerned with the general expression of properties and relationships of magnitudes in space. Thus one of their major advantages is that they become intuitively useful in deciding on the most elementary, but fundamental, of all questions about any prototype: Does the prototype inhabit a spatial form which is potentially realizable in *real* space?

This is a prime question. It is a question of *existence* whose answer must either be ensured experientially or be logically inferred beforehand. However, once this first level of existence is satisfied, the process of its intuitive acceptance has to be immediately questioned, so that the extent of the architectural validity (hence prototypicality) of the defined spatial form becomes subject to critical analysis. This involves a shift in interest. As emphasized in the previous chapter, it becomes primarily a concern with functional adaptability, that is a concern with the discovery, elaboration and evaluation of what is architecturally possible. Therefore, prior to the full engagement at this level of consideration, the use of the term 'prototype' in conjunction with any spatial form remains provisional, as is the case with the example proposed here. The various ways in which it is to realize its full architectural potential and the comparative value of that potential can only be part of a long-term project of research and development which extends far beyond this limited presentation.

The first step is to introduce the prototypic polyhedron on the basis of a combined mathematical/architectural terminology,

thus giving it an architectural character from the start. The second step is to define and characterize the geometrical properties of this prototypic polyhedron in some detail. This is followed by the identification of its *parent group* of polyhedra, the so-called *cubo-dodecahedra*. Their close links (especially those of the prototypic polyhedron) with several other well-known geometrical figures and their combinatorial and juxtapositional possibilities with these are then duly explored. Next, the discussion deals with the potential of the prototypic polyhedron for achieving a 'physical reality' considering questions of structural stability and rigidity within the context of some general structural systems, but without going into detailed building structural analysis or methods of construction. After this follows an elaboration of a variety of spatial possibilities which start to multiply rapidly once the strict adjacency rules imposed at the beginning are relaxed. Finally, several areas for further research are suggested.

The general exposition itself has no pretence to great mathematical rigour. It does not refrain from introducing a measure of informality or speculative argument whenever this is found helpful in emphasizing the operational character and design potential of the prototype. This high level of informality is, in fact, a true reflection on the way the results originated. Most of them are a product of intuitive derivation from earlier ones or an experimentation with cardboard models and sketches. The best strategy of presentation, it is felt, therefore, is to give results directly and illustrate them graphically, rather than to

complicate the exposition and disrupt its continuity with detailed formal proofs. As a supplement to this an exclusively graphical appendix on many compositional ideas has been provided in the form of Appendix III to this thesis.

## 10.2 INTRODUCTORY DESCRIPTION OF THE PROTOTYPIC POLYHEDRON

Before proceeding to give a detailed geometrical characterization of the prototypic polyhedron, it will be helpful to give a brief description of it. This deliberately uses a combined mathematical/architectural terminology, thus establishing the first important link between the prototypic polyhedron and architecture. Aided by Fig. 10.2 and Photo, 10.1, the following observations can be made:

1. The prototypic polyhedron is convex, 10-flat-faced and has different classes of vertices, edges, faces, and facial and dihedral angles.
2. The *roof* (or *roof-unit*) is made of three mutually and orthogonally-adjacent square panels or faces labelled as ABCD, ADEF and ABGF, respectively. These panels are incident on a regular hexagonal *floor plan* (i.e. the hexagonal base labelled as CJEKGI) at three points, the *roof footing vertices* C, E and G, respectively.
3. The *walls* (i.e. the vertical faces labelled as BIC, BIG, DJC, DJE, FKE and FKG) are made of six mutually congruent right-angled triangular panels with the vertical line segments BI, DJ and FK as co-edges. The remaining two angles in each

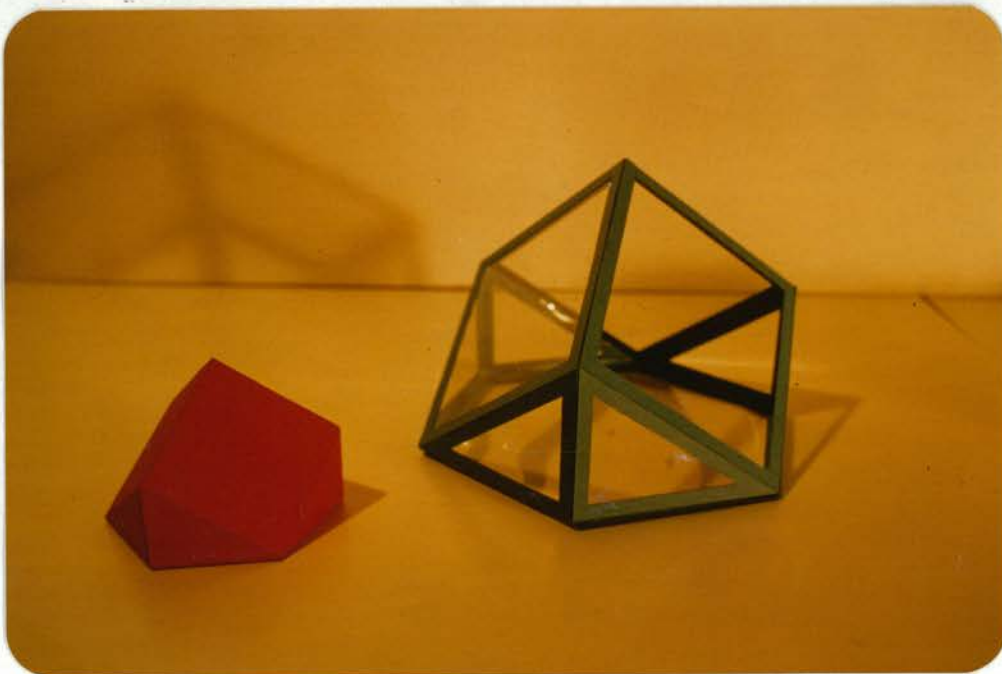
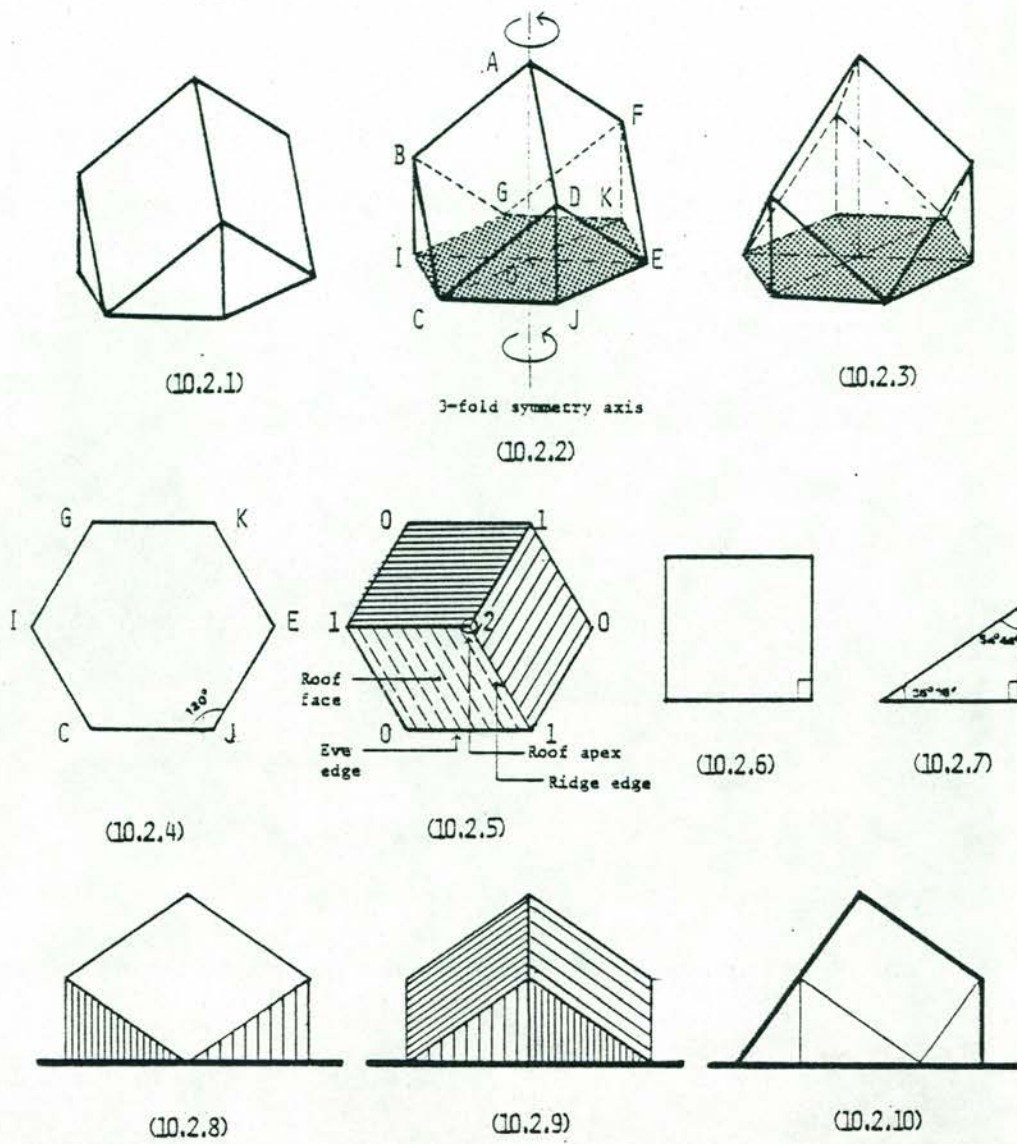


Fig. 10.2 & Photo. 10.1 The prototypic Polyhedron

triangular face have the values  $54^{\circ} 44'$  and  $35^{\circ} 16'$ , respectively.

4. The vertex labelled as A is unique. It represents the *roof apex* and is situated vertically above the hexagonal floor plan circumcentre, the point O.
5. The whole polyhedron is centrally symmetric around a 3-fold symmetry axis perpendicular to the floor plan plane, and passing through the apex (A) and the floor plan circumcentre (O).
6. There are two types of standard elevations (depicted by Figs. 10.2.8 and 10.2.9) and only one type of standard cross-sections (depicted by Fig. 10.2.10).

An important point for the whole of this exposition is that all polyhedral forms can be considered as combinations of surfaces and edges, where edges describe the boundaries to surfaces<sup>5</sup>.

Volumes are formed out of assemblies of surfaces that are non-co-planar but with contiguous edges. There will be instances when such edges will be called *co-edges*. The term contiguous or adjacent refers to a common edge or edges forming the junction between two or more surfaces. The state of *contiguity* or *adjacency* may be considered as an important part of any description of a polyhedral figure. When describing or evaluating any solid geometrical figure, questions might be asked about angles, edges, surfaces, volumes or combinations of any of these, such as questions relating to quantity measures of say angles (in degrees), edges (in lengths), surfaces

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5. *The discussion in this and the ensuing paragraph is adapted, with several modifications to suit the discussion here, from Bijl (1977, pp.62-3).*



(in areas) or volumes (in volumes). More taxing questions might refer to the relative positions in space of two or more contiguous or adjacent surfaces in order to establish the form of junction along a contiguous edge or edges. These questions mainly refer to quantity measures of dihedral angles and sometimes to lengths or orientations of contiguous edges.

Classes of polyhedral forms, therefore, may be defined by applying geometric (size and shape) constraints to angles, edges, surfaces and volumes. The motivation for applying these constraints, besides their purely geometric interest, may arise from the material contexts in which these polyhedral forms are to be employed in, for instance, sciences of the artificial, where the purposes of the objects that relate to them and the resources available for the execution of these objects are paramount. A case in point is the one relating to built forms.

The following clarification of terminology is also found necessary to the discussion in the rest of this chapter. From now on, unless otherwise specified, the terms 'prototypic unit' or 'prototypic cell' will be used interchangeably with the term 'prototypic polyhedron'. The 'prototypic skeleton' or 'framework' is the union set of all the edges defining the prototypic polyhedron and its principal surfaces. More generally, the terms edge, side or line segment will be used interchangeably; as also will the terms vertex, node or point, on the one hand, and the terms face, panel or polygon, on the other. A dihedral angle (d-angle) is an interfacial angle (that is an angle between two faces), while a facial angle (f-angle) is a polygonal angle (that is

an angle described by the intersection of two edges in the same face or polygon). The abbreviations and notations listed in Table 10.1 are of general use. Others will be defined within the text.

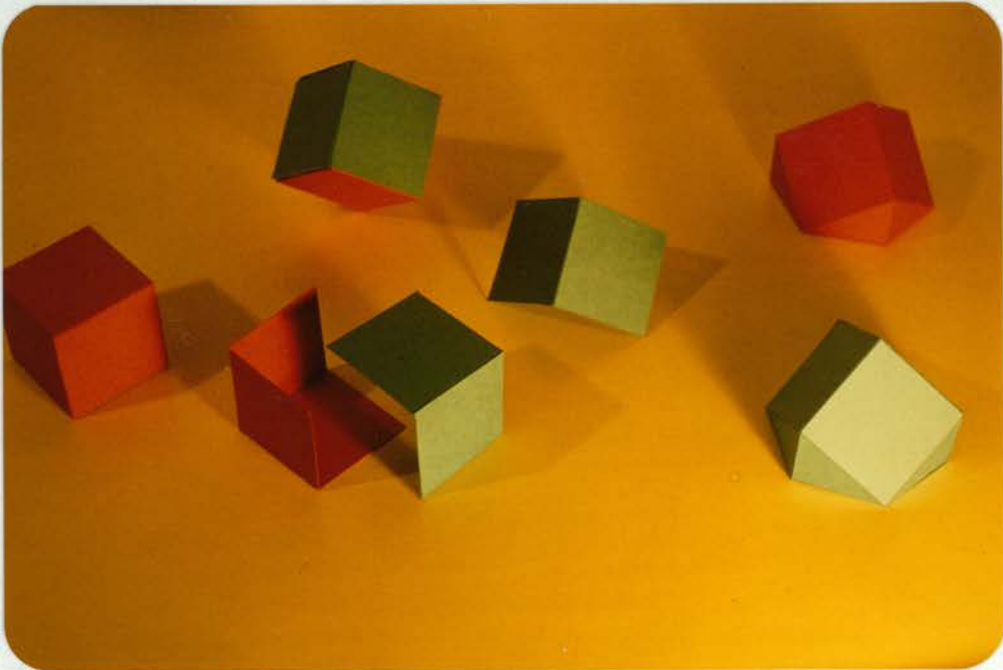
Table 10.1

|        | ABBREVIATION<br>OR NOTATION  | DESCRIPTION  |
|--------|--|--|
| Faces  | h-face<br>p-face<br>r-face<br>s-face<br>t-face<br>tr-face<br>n-f-faces | hexagonal face<br>parallelogrammic face<br>rhombic face<br>square face<br>triangular face<br>trapezium face<br>the class of faces whose number is $n$ and whose type is $f$ , where $f$ is any face as defined. For instance, $n$ -s-faces for the class of $n$ square faces.  |
| Angles | $m-X^0$<br>$X_f^0$<br>$X_{f/f}^0$                                      | the class of angles whose number is $m$ and whose standard value is $X$ degrees.<br>the facial angle whose value is $X$ degrees and contained in the face $f$ as defined. For instance, $X_t^0$ is defined in a triangular face. We may also have $m-X_f^0$ for a class of $m$ facial angles.<br>the dihedral angle whose value is $X$ degrees and contained between the faces $f$ and $f$ as defined. For example $X_{h/t}^0$ is defined by a hexagonal and $h/t$ a triangular face. We may also have $m-X_{f/f}^0$ for a class of $m$ dihedral angles. |

10.3 GEOMETRICAL REALIZATION AND CHARACTERIZATION OF THE PROTOTYPIC POLYHEDRON

The process of geometrical realization of the prototypic polyhedron can be approached in many ways, but the most interesting

and straightforward one involves the *cube* as a *generator* (see Fig. 10.3; Photo.10.2). Take any unit similar to the orthogonal 3-s-faced unit ABCDEFG in Fig. 10.3.4, rotate in the space and bring the three equivalent vertices C, E and G to rest on the horizontal plane (Fig. 10.3.5). In this position, the figure ABCDEFG represents what has been termed above as the *roof unit*. When the three line segments BI, DJ and FK are projected perpendicularly down to touch the horizontal plane (Fig. 10.3.6) three equivalent points (I, J and K, respectively) are obtained on that plane. The six points C, J, E, K, G and I are the vertices of a regular hexagon. This is what has been referred to above as the *floor plan*. The six upright triangular faces are the *wall panels*. The completed prototypic polyhedron under construction is shown in Fig. 10.3.8 (see also Photo.10.2).



Photo, 10.2



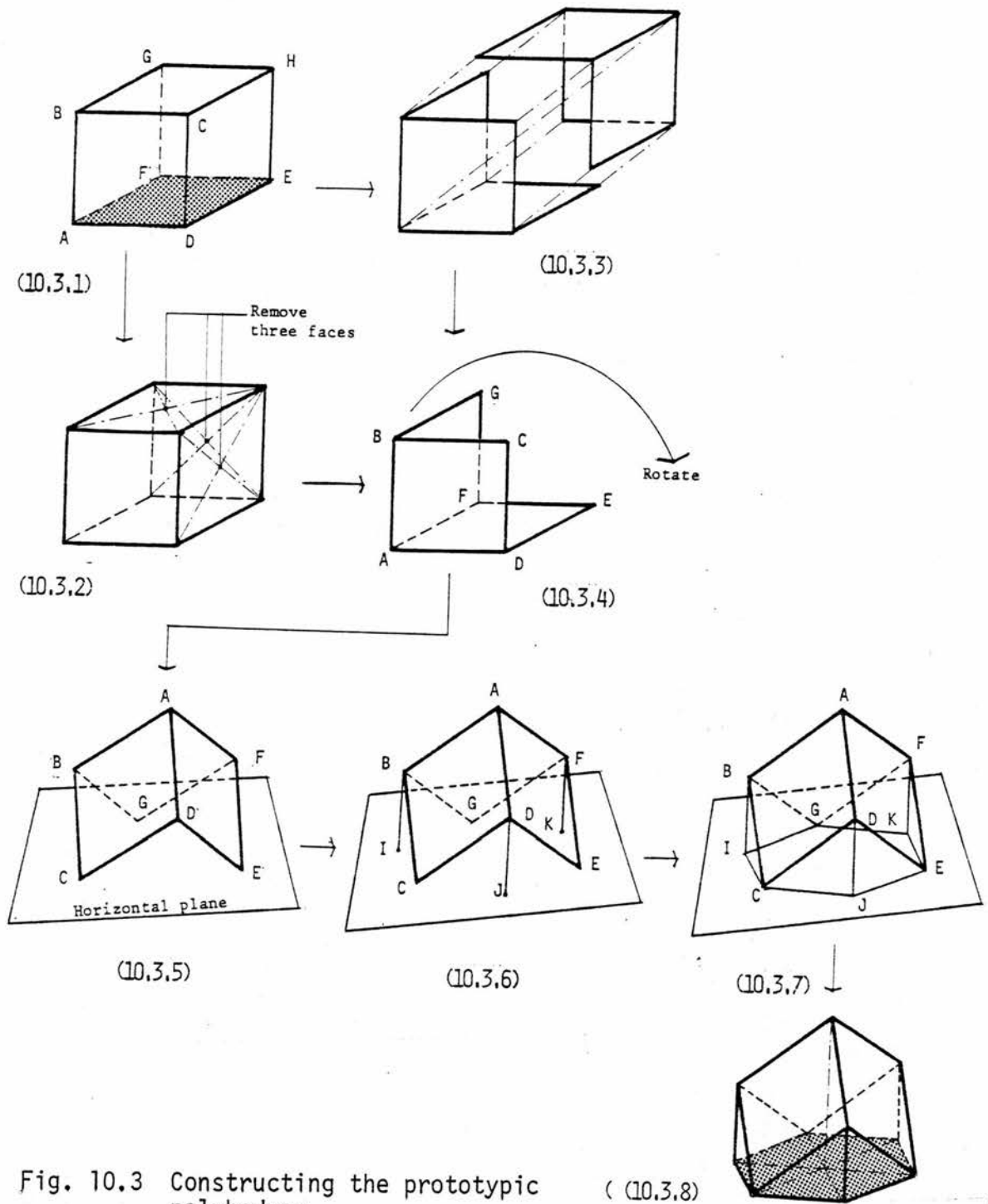


Fig. 10.3 Constructing the prototypic polyhedron (10.3.8)

Fig. 10.4 represents the complete planar net required for constructing a cardboard model of the prototypic polyhedron. As a comparison also, the corresponding generating cube ABCDEFGH has been superimposed on Fig. 10.3.8, rotated and, then, shown as Fig. 10.5.

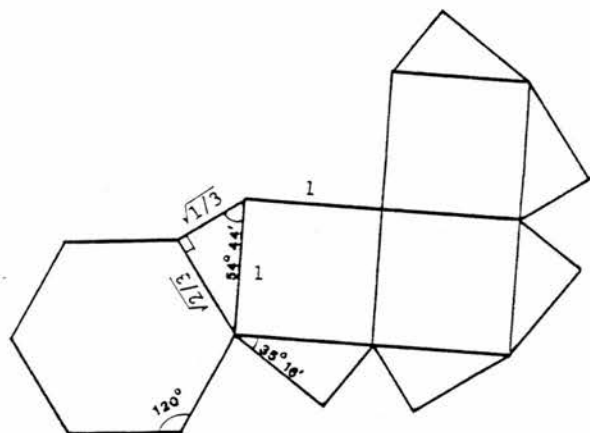


Fig 10.4 The prototypic polyhedron:  
the complete planar net

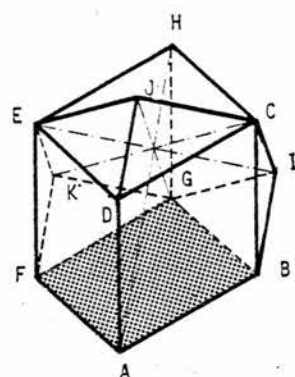


Fig. 10.5 The prototypic  
polyhedron and generating  
cube superimposed on each  
other

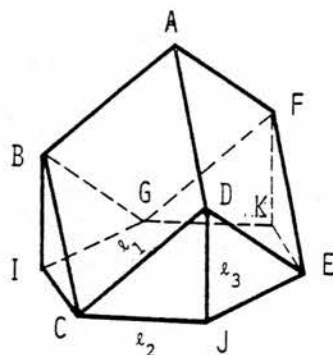
There are three standard classes of 'fundamental edges' in the prototypic polyhedron: the class ' $\ell_1$ ' (with nine members such as AB); the class ' $\ell_2$ ' (with six members such as CJ); the class ' $\ell_3$ ' (with three members such as BI). There is a total of eighteen edges in the prototypic polyhedron. In notational terms, each edge will be assigned the name of its class, thus we have the *fundamental edge*  $\ell_1$ ,  $\ell_2$  or  $\ell_3$ . The class  $\ell_1$  are all edges in the *generating cube*. They are the defining edges of the three s-faces describing the roof unit (Fig. 10.3.5). The class  $\ell_2$  characterises the h-face CJEKGI (the *base* or the *floor plan*), while  $\ell_3$  describes the vertical co-edges in the t-faces (the *walls*). The three fundamental edges are, in fact, uniquely described by every t-face. Take, for instance, the t-face CDJ (Fig. 10.6). In this triangle

the following holds (Pythagoras Theorem):

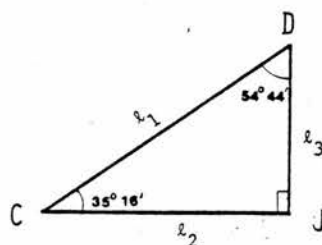
$$CD^2 = CJ^2 + DJ^2$$

or  $l_1^2 = l_2^2 + l_3^2$

Fig. 10.6



(10.6.1)



(10.6.2)

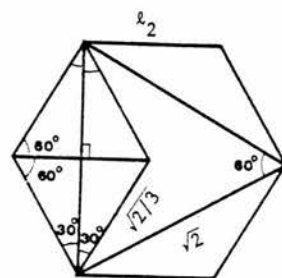
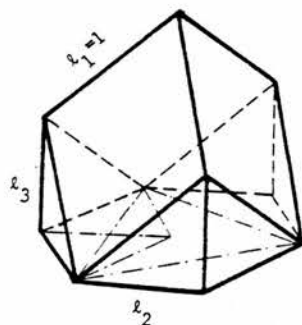
The f-angles in every t-face (Fig. 10.6.2) are  $35^\circ 16'$ ,  $54^\circ 44'$  and  $90^\circ$ , respectively. The value  $54^\circ 44'$  is, actually, equal to that of the d-angle between every s-face (roof panel) and the h-face (see Fig. 10.10).

Taking  $l_1$  as unity (Fig. 10.7), the relative magnitudes of  $l_1$ ,  $l_2$ ,  $l_3$  are as follows:

$$l_1 : l_2 : l_3$$

$$1 : \sqrt{\frac{2}{3}} : \frac{1}{\sqrt{3}}$$

Fig. 10.7



An equally important *linear dimension* in the prototypic polyhedron is the perpendicular height of the apex (point A) from the h-face plane. Denote this by the symbol ' $l_4$ '. Since  $l_4$  is not an edge in the prototypic polyhedron, but only a linear dimension, then, the group  $l_1$ ,  $l_2$ ,  $l_3$  and  $l_4$  will be commonly referred to as the *fundamental linear dimensions*. When  $l_1$  is once again taken as unity, the relative magnitudes of these dimensions are as follows:

$$l_1 : l_2 : l_3 : l_4$$

$$1 : \sqrt{\frac{2}{3}} : \frac{1}{\sqrt{3}} : \frac{2}{\sqrt{3}}$$

A first observation is that the relative magnitude of  $l_4$  is always twice that of  $l_3$ . In fact, the relative magnitudes of  $l_1$ ,  $l_2$ ,  $l_3$  and  $l_4$  can be expressed in a variety of interesting ways. See, for instance, the examples shown in Fig. 10.8. Taking  $l_3$  as unity, then:

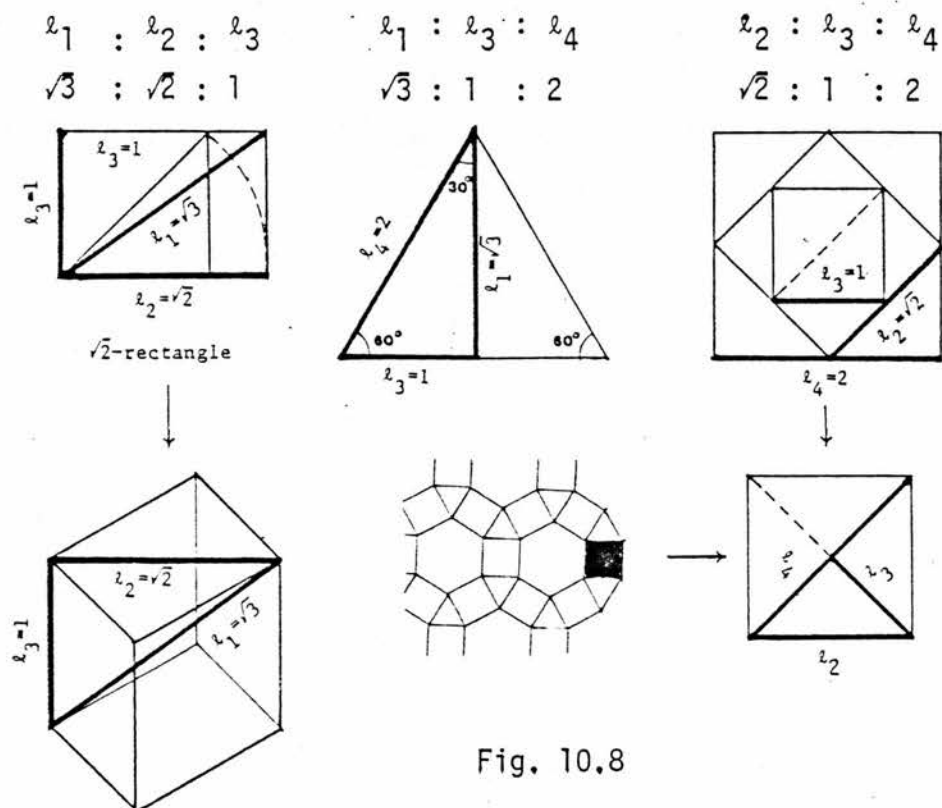


Fig. 10.8

There are four classes of vertices in the prototypic polyhedron (depicted by Fig. 10.9). These classes differ according to both the edge-valencies<sup>6</sup> of their respective vertices and the types of faces which are incidental on them. Both differences may be used for the purpose of characterization. When writing  $m-n$ -valent/ $f/f...$ ,  $m$  is the number of vertices in each class,  $n$  is the edge-valency of each vertex and  $f$  is a face-type which is incidental on the vertex and which has more than one member.

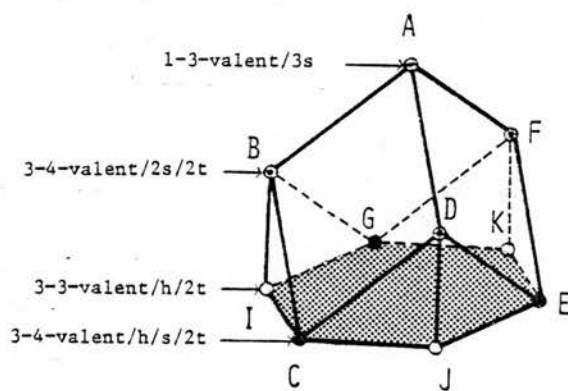


Fig. 10.9 Vertex valencies

There are five classes of d-angles in the prototypic polyhedron (Fig. 10.10);  $3-90^{\circ}_{2s}$ ,  $6-125^{\circ} 16'_{s/t}$ ,  $3-90^{\circ}_{h/s}$ ,  $6-90^{\circ}_{h/t}$ ,  $6-120^{\circ}_{2t}$ .

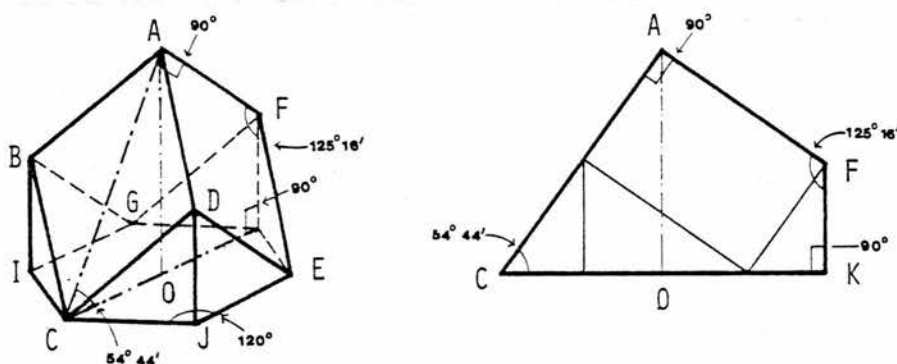


Fig. 10.10 Dihedral angles

6. Vertex valency may be defined according to the number of incident edges, incident faces or incident space cells. In this study (unless otherwise specified) vertex valency is defined in terms of the number of incident edges.

The facial angles in the prototypic polyhedron can be classified, into five classes;  $12-90^{\circ}_s$ ,  $6-90^{\circ}_t$ ,  $6-54^{\circ} 44'_t$ ,  $6-35^{\circ} 16'_t$ ,  $6-120^{\circ}_h$ .

Other parameters which are of importance both geometrically and architecturally are the following:

$A_1$ , denoting the area of the h-face (i.e. the floor plan);

$A_2$ , denoting the area of an s-face (i.e. a roof panel);

$A_3$ , denoting the area of a t-face (i.e. a wall panel);

$A_4$ , denoting building surface area (i.e. total surface area less the h-face area);<sup>7</sup>

$A_5$ , denoting total surface area;

$V$ , denoting total polyhedral volume.

Table 10.2 lists the different invariant factors or constants which relate the four fundamental linear dimensions  $\ell_1$ ,  $\ell_2$ ,  $\ell_3$  and  $\ell_4$  to each other and also to the parameters just enumerated. The first column corresponds to taking  $\ell_1$  as known, the second column corresponds to taking  $\ell_2$  as known and so on. The appropriate factors are enclosed by brackets.

When exploring the architectural potential of the prototypic polyhedron, Table 10.2 and its derivatives can, of course, have many uses. It can be easily extended and, therefore, used in, for

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7. *This is called building surface area due to its importance in architectural studies; for instance, in quantity surveying, environmental performance studies etc. Usually, when architects talk about building surface area, they evidently refer to what is otherwise known as envelope area, which excludes the sum area of floor plans due to the fact that these are either part of the earth surface or otherwise enclosed within buildings.*

Table 10.2:  $y = bx^\alpha$ 

| $\begin{matrix} x \\ y \end{matrix}$ | 1                                | 2                                     | 3                                   | 4                                     |
|--------------------------------------|----------------------------------|---------------------------------------|-------------------------------------|---------------------------------------|
| $\ell_1$                             | (1)                              | $(\sqrt{3}/2)$                        | $(\sqrt{3})$                        | $(\sqrt{3}/2)$                        |
| $\ell_2$                             | $((2\sqrt{3})/3)$                | $(\sqrt{2})$                          | (2)                                 | (1)                                   |
| $\ell_3$                             | $(\sqrt{3}/3)$                   | $(\sqrt{2}/2)$                        | (1)                                 | $(1/2)$                               |
| $\ell_4$                             | $(\sqrt{2}/3)$                   | (1)                                   | $(\sqrt{2})$                        | $(\sqrt{2}/2)$                        |
| $A_1$                                | $(\sqrt{3}) \cdot \ell_1^2$      | $(3\sqrt{3}/2) \ell_2^2$              | $(3\sqrt{3}) \ell_3^2$              | $(3\sqrt{3}/4) \ell_4^2$              |
| $A_2$                                | $(1) \ell_1^2$                   | $(3/2) \ell_2^2$                      | $(3) \ell_3^2$                      | $(3/4) \ell_4^2$                      |
| $A_3$                                | $(\sqrt{2}/6) \ell_1^2$          | $(\sqrt{2}/4) \ell_2^2$               | $(\sqrt{2}/2) \ell_3^2$             | $(\sqrt{2}/8) \ell_4^2$               |
| $A_4$                                | $(3+\sqrt{2}) \ell_1^2$          | $(3(3+\sqrt{2})/2) \ell_2^2$          | $(3(3+\sqrt{2})) \ell_3^2$          | $(3(3+\sqrt{2})/4) \ell_4^2$          |
| $A_5$                                | $(\sqrt{3}+3+\sqrt{2}) \ell_1^2$ | $(3(\sqrt{3}+3+\sqrt{2})/2) \ell_2^2$ | $(3(\sqrt{3}+3+\sqrt{2})) \ell_3^2$ | $(3(\sqrt{3}+3+\sqrt{2})/4) \ell_4^2$ |
| $V$                                  | $(1) \ell_1^3$                   | $((3\sqrt{6})/4) \ell_2^3$            | $(3\sqrt{3}) \ell_3^3$              | $((3\sqrt{3})/8) \ell_4^3$            |

instance, analysing various possibilities of spatial organization; obtaining quick estimates of contents of building materials; investigating environmental performance and so forth. Some preliminary comparisons can also be made between the prototypic polyhedron and other geometrical figures. Take, for instance, the value enumerated in the heavily marked box ( $V\ell_1$ ).  $\ell_1$  is the fundamental edge in the corresponding generating cube and, therefore, the value  $\ell_1^3$  shows that the total volume of the prototypic polyhedron is equal to the volume of that cube (see Fig. 10.11 for graphical illustration). Yet, the prototypic polyhedron covers a floor plan area ( $A_1$ ) which is  $\sqrt{3}$  times that covered by one of the cube s-faces ( $A_2$ ) (Fig. 10.12),





From the outset, these advantages which the prototypic polyhedron has over the cube are, of course, interesting. Nevertheless, it would be premature, at this preliminary stage, to conclude that a prototype based on the prototypic polyhedron would automatically be superior to one based on the cube. A conclusion of this kind can only be properly reached after an extremely extensive comparative investigation which goes far beyond these first observations. Indeed, to be of real value such a comparison must also involve other geometrical figures. And yet still there can be no guarantee that such a comparative investigation will lead (or should necessarily lead for that matter) to a conclusion once and for all of the superiority of a prototype originated in one geometrical figure over all the others, and in every respect. In fact, since every geometrical figure can be shown to have overlapping elements or characteristics with every other, so will the prototypes based on them. Quite significantly, the prototypic polyhedron and the cube remain firmly related in a number of ways, not least when the cube acts as the most direct generator of it and equal to it in terms of volume, but also because it is the chief generator of the whole of the new parent group of polyhedra of which the prototypic is a sub-member. Furthermore, the cube can be easily joined to the  $s$ -faces in the prototypic polyhedron or its parent group, thus giving rise to some interesting spatial configurations (see, for instance, Fig. 10.63).

An aspect about the volume of the prototypic polyhedron which might also be of interest is that it is equal to half the volume of the hexagonal prism which circumscribes it (see Fig. 10.13, for

illustration). Furthermore, the rhombic-based space cells depicted by Fig. 10.13.4 show that both the prototypic polyhedron and its circumscribing hexagonal prism can be decomposed into the same rhombic-based sub-cells.

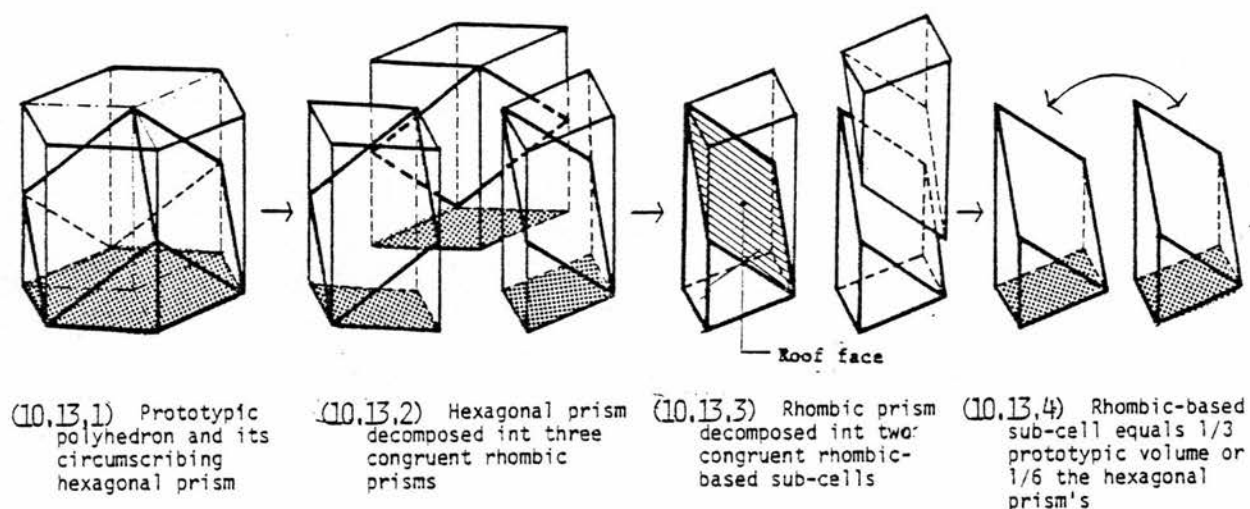


Fig. 10.13

In fact, around its 3-fold symmetric axis, the prototypic polyhedron can be decomposed into two types of rhombic-based sub-cells (Figs. 10.14.3 and 10.14.3'), which, in turn, can be further 'mirror' decomposed into the same equi-triangular-based sub-cells (Figs. 10.14.5 and 10.14.5'). When any of the sub-cells characterized

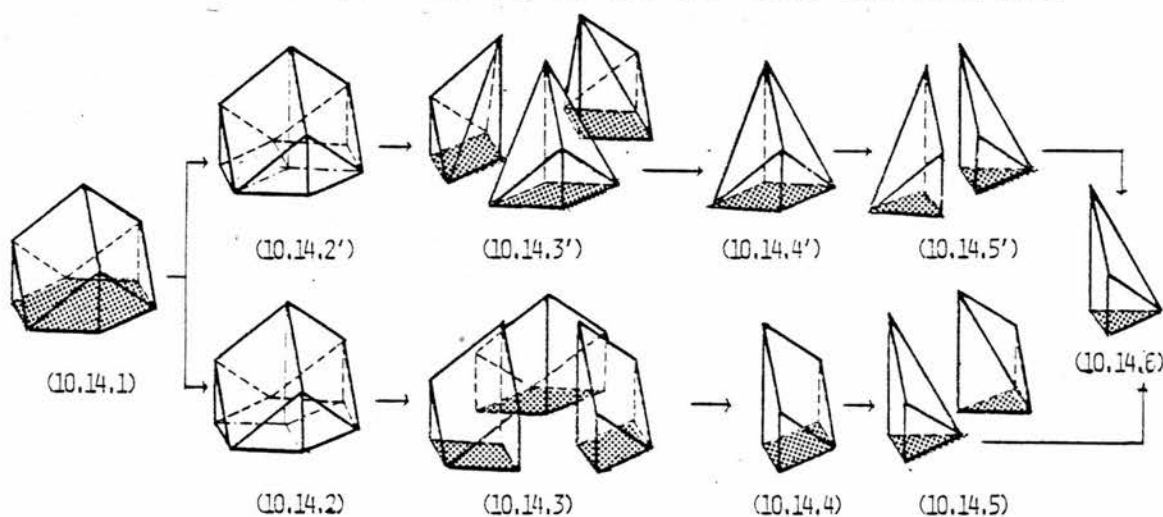


Fig. 10.14

(whether equi-triangular-based or rhombic-based) or the prototypic polyhedron itself is *properly* joined (through perfect congruence; see, for instance Figs. 10.15, 10.16 and 10.17) along whole vertical faces with units that are co-planar and equal in size, a densely packed triangular, rhombic or hexagonally tessellated geometric landscape results, respectively (see Figs. 10.18 and 10.19, for two corresponding examples on the floor plan and roof plan of the prototypic polyhedron).

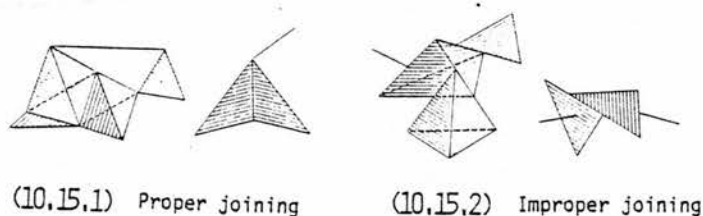


Fig. 10.15 Proper and improper joining.  
(According to Hocking and Young,  
1961, p.201)

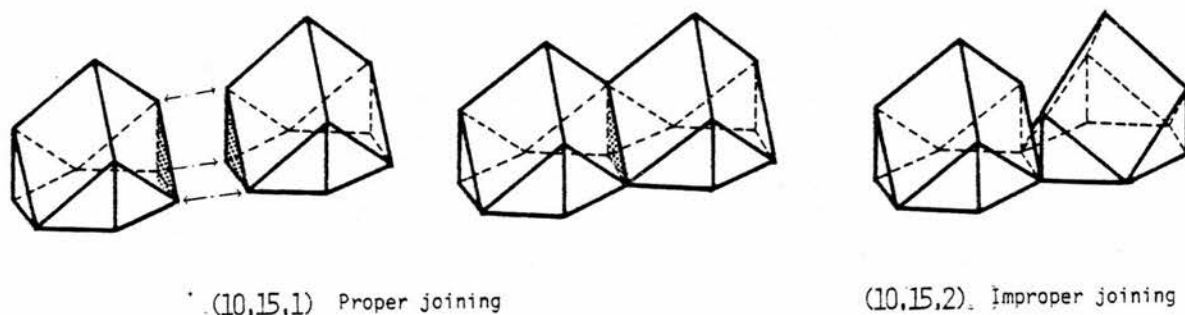


Fig. 10.16 Proper and improper joining of prototypic polyhedra

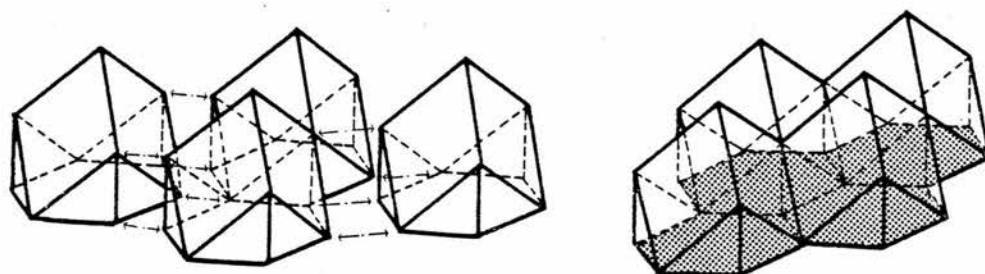


Fig. 10.17 Two ways of proper joining of every three prototypic polyhedra

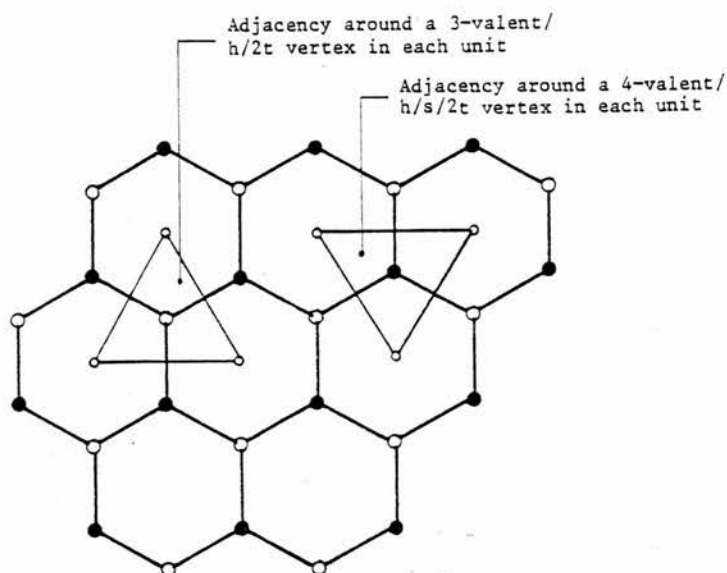


Fig. 10.18 Randomly elaborated floor plans<sup>8</sup>

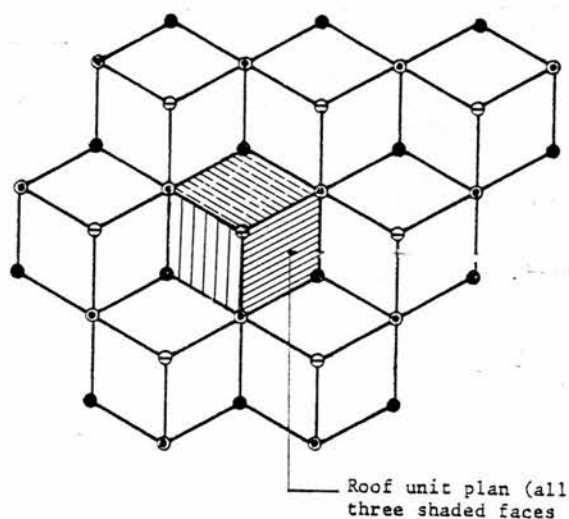


Fig. 10.19 Corresponding roof plans to Fig. 10.18

8. The fact that the prototypic unit sits on a hexagonal floor plan gives it a special quality. There have been many arguments in favour of hexagonality. In particular instances, hexagonal tessellations are seen to be superior (for reasons of economy) to both the square and triangular tessellations. Of the three polygons, the hexagon is the one which mostly approximates the circle, while at the same time it can be joined by others on six sides. Also, together with its approximations and the space structures based on them, it has proved a popular structure in nature. The most famous example of this is, of course, the one realized in the honeycomb of the bee (see D'Arcy Thompson, 1964 [1917], for a classic treatment of this and many other natural geometries.

Most importantly, the prototypic polyhedron and its rhombic and triangular-based sub-cells can be used singly or collectively to pack the space solidly without gaps or overlappings. Fig. 10.20 depicts this property as regards the prototypic polyhedron. This space-filling property provides for many practical architectural possibilities, such as the generation of multi-level configurations (see, for instance, Fig. 10.21) or double-planar structural space-frames (see Fig. 10.47) and so on. The space-filling based on the prototypic polyhedron is usually distributed on a three-layered system of congruent regular hexagons, where the points of the middle

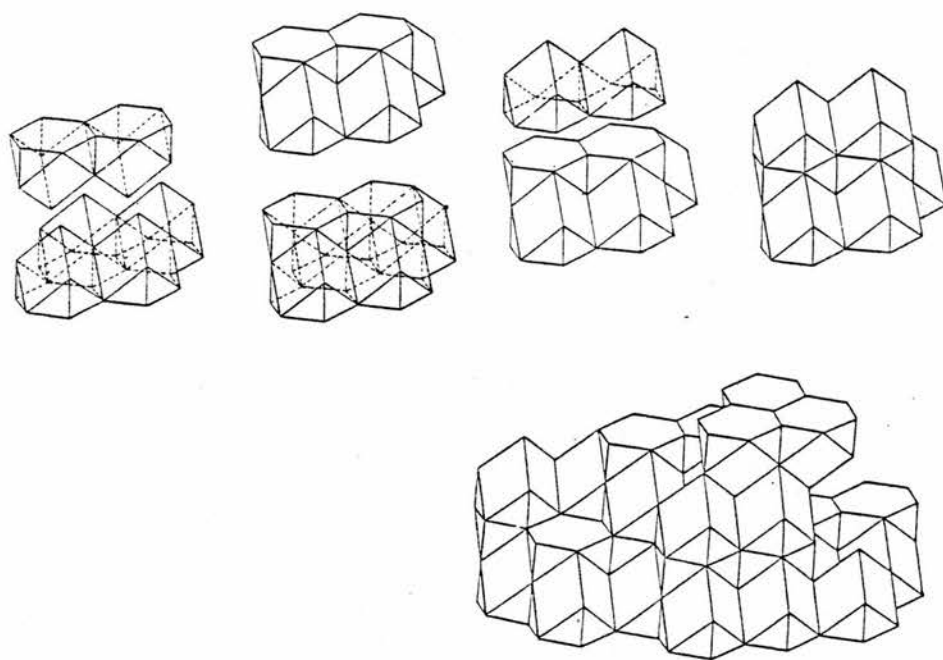


Fig. 10.20 Prototypic polyhedron as a space-filling solid

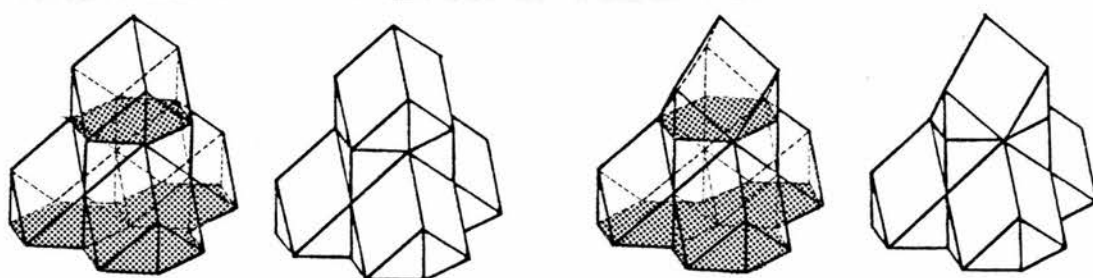
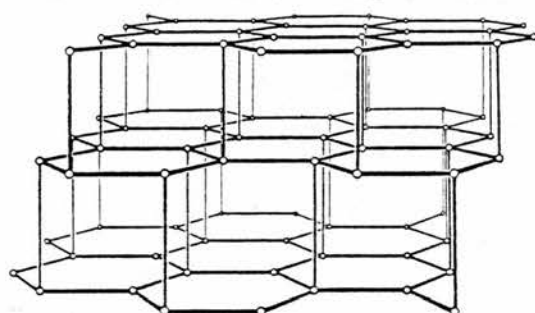
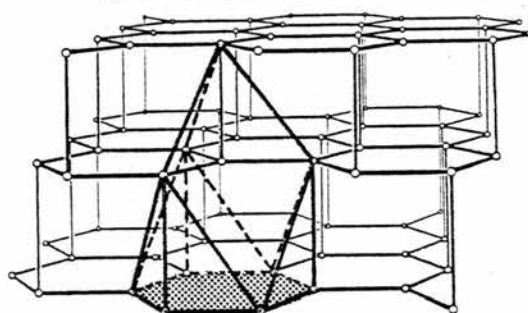


Fig. 10.21 An example on multi-storey compositions

layer are alternately vertically situated below a point of the upper layer and vertically above a point of the lower layer. This spatial structure can be extended indefinitely in all directions. More significantly, it has several interesting symmetry properties. There is no room to go into the details of these here, but it is interesting to observe that this structure is exactly equivalent to the one generated by a graphite crystal as has been shown by Hilbert and Cohn-Vossen (1952, p.52; see Fig. 10.22 for illustration and juxtapositioning of the prototypic polyhedron).



(10.22.1) Graphite crystal structure.  
(According to Hilbert and Cohn-Vossen, 1952, p.54)



(10.22.2) A slightly transformed prototypic skeleton juxtaposed on graphite crystal structure

Fig. 10.22

#### 10.4 GEOMETRICAL EXTENSIONS AND 3-DIMENSIONAL ANALOGUES

Before characterizing the prototypic polyhedron's parent group of polyhedra, it is of interest to refer, first, to the close relationship between it and several other well-known geometrical figures. As an illustration, only the tetrahedron and the sphere are considered here. In both cases, the cube will be involved. For instance, the tetrahedron (Fig. 10.23.1) can be used to inscribe the cube (Fig. 10.23.3) or the prototypic polyhedron (Figs.

10.23.3' and 10.23.3''). The three solids can be juxtaposed simultaneously on each other as depicted by Fig. 10.23.4.

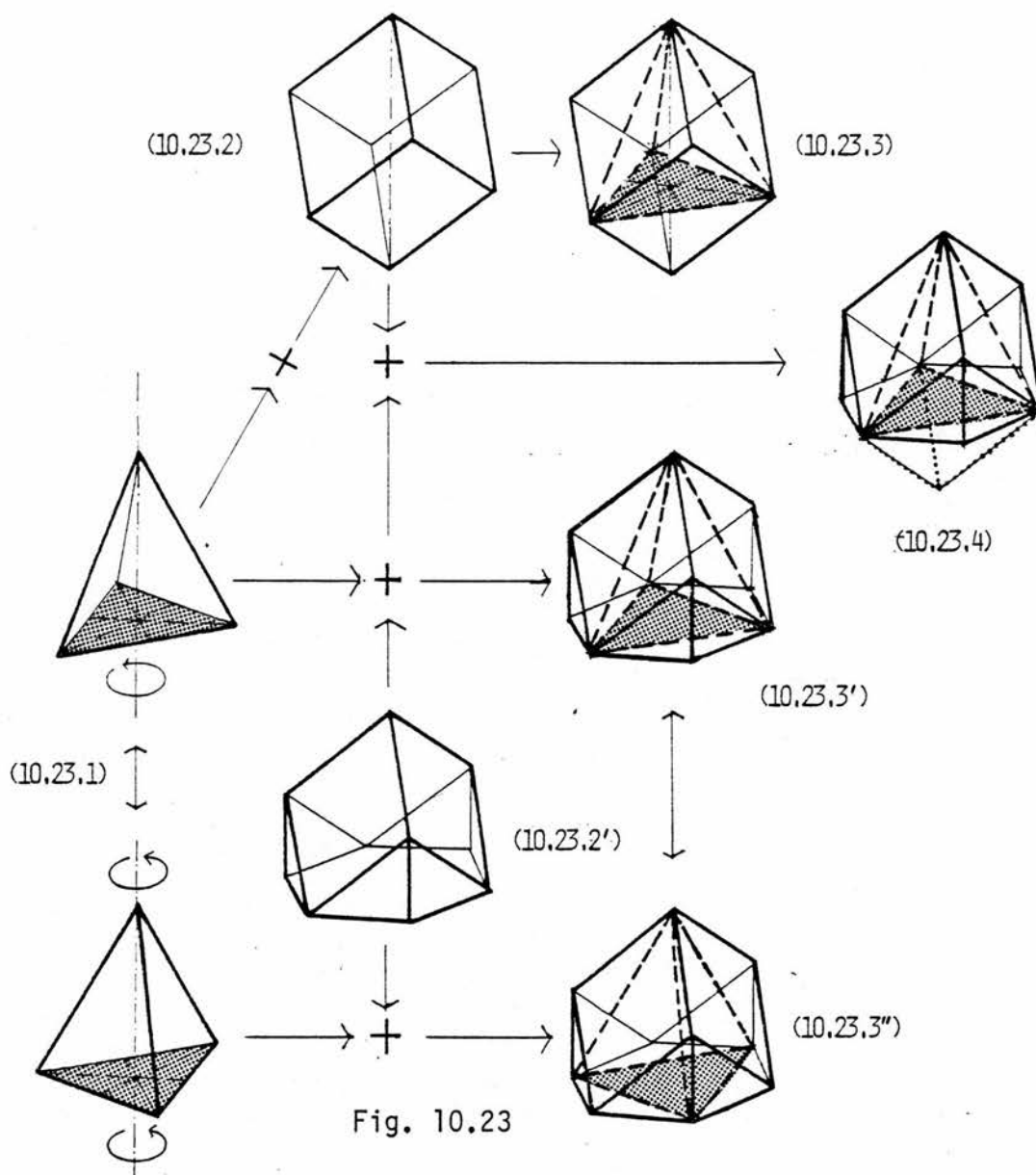


Fig. 10.23

Of the two ways of inscribing the prototypic polyhedron with a tetrahedron, the first (Fig. 10.23.3') is the more interesting since it results in the *full-facial triangulation*<sup>9</sup> of the prototypic

9. The property of full triangulation is achieved when the number of edges in a polyhedron is or made equal to  $3V-6$ , where  $V$  is the number of vertices. (For a well articulated discussion on triangulation and structural stability, see Loeb, 1976; Chapter 6, in particular. See also Pearce, 1978, for an elaborate and architecturally orientated treatment).



polyhedron (thus guaranteeing its structural stability and rigidity, at least geometrically<sup>10</sup>), while leaving its inside and outside spaces free of obstruction as they have been originally prior to this particular inscription.

In relation to the sphere, both the prototypic polyhedron and the corresponding generating cube can be inscribed by the same sphere (Fig. 10.24). The three figure are, of course, concentric (at  $O_s$ ).  $O_p$  represents the circumcentre of the prototypic polyhedral base. AH, BE, CF and DG are the cube's four body diagonals. They are also, of course, diameters in the circumscribing sphere.

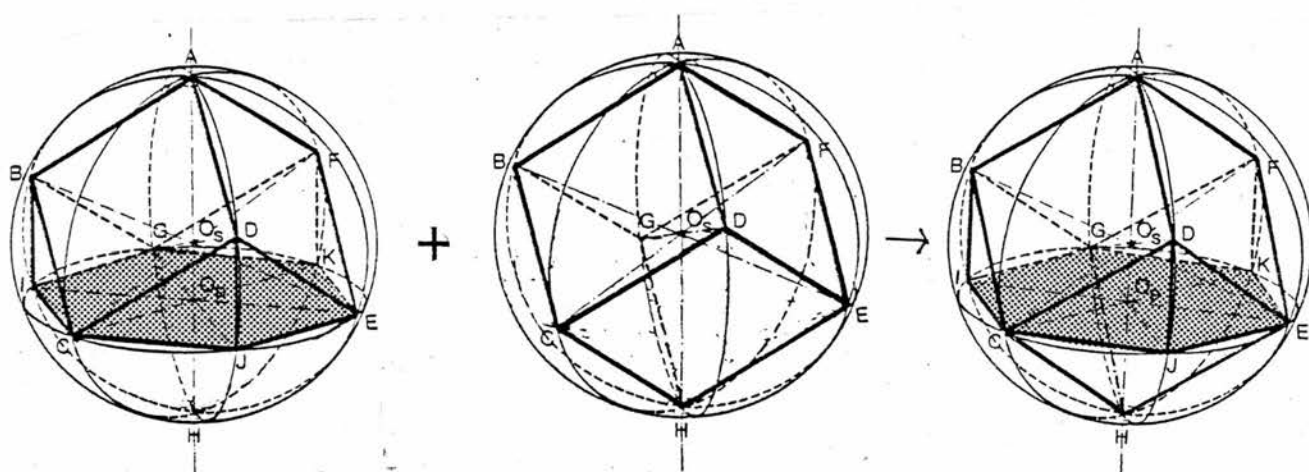


Fig. 10.24 The prototypic polyhedron, the cube and their joint circumscribing sphere

More specifically, the prototypic polyhedron sits in a  $\frac{2}{3}$ -sphere (Fig. 10.25), that is the relative magnitude of its  $\ell_4$  (the height of the apex vertex) to the circumscribing sphere's diameter is 2:3.

- 
10. According to Loeb (1976, p.34), regardless of how they are interconnected,  $V$  vertices require exactly  $3V-6$  interconnections to be stabilized. However, though a  $V$ -vertex polyhedron may not need all  $(3V-6)$  interconnections to achieve structural stability, a polyhedron with such a number of interconnections all along its faces (i.e. none are cross-sectional diagonals) will be fully triangulated.



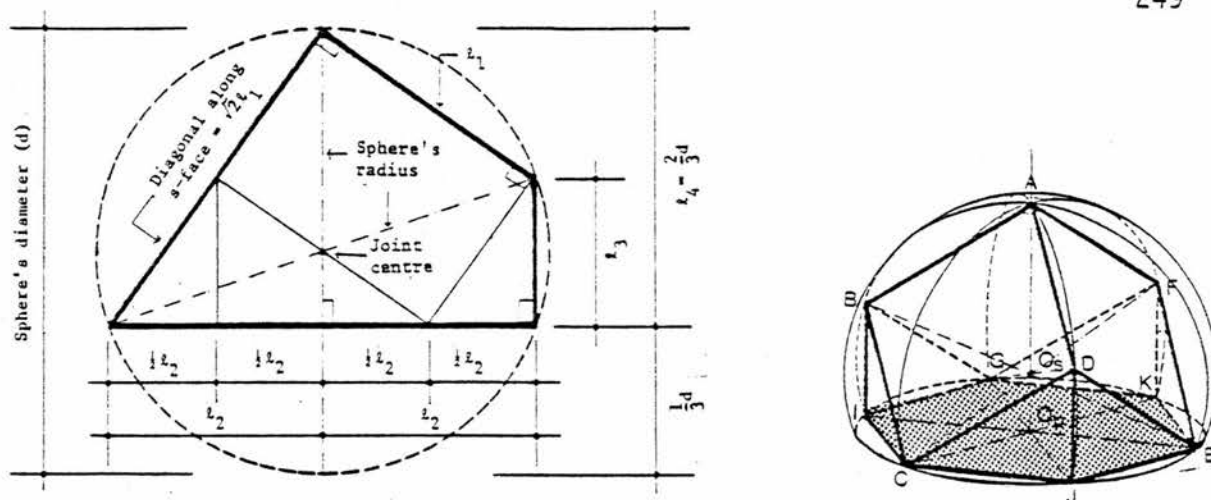


Fig. 10.25 The prototypic polyhedron and the  $\frac{2}{3}$  sphere in which it sits

It is appropriate now to develop the exact link between the prototypic polyhedron and its parent group of polyhedra. Both types of polyhedra are new and their identification and characterization remain an independent effort by the author. The parent group originates in two figures each of which is a double figure of the prototypic polyhedron. The *first double-figure* represents an exact 'mirror' alignment of two prototypic polyhedra along their respective h-faces (Fig. 10.26). The *second double-figure* represents a

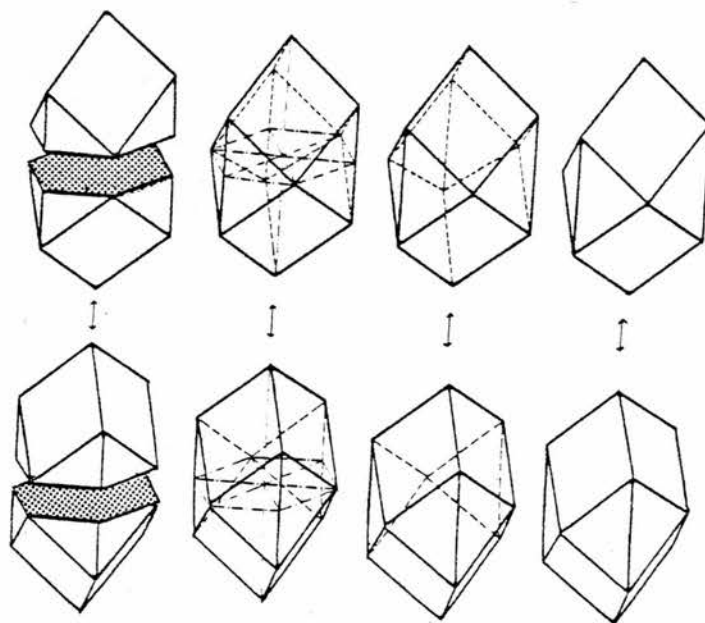


Fig. 10.26 The first prototypic double-figure

60°-twisted alignment of two prototypic polyhedra along their respective h-faces (Fig. 10.27).

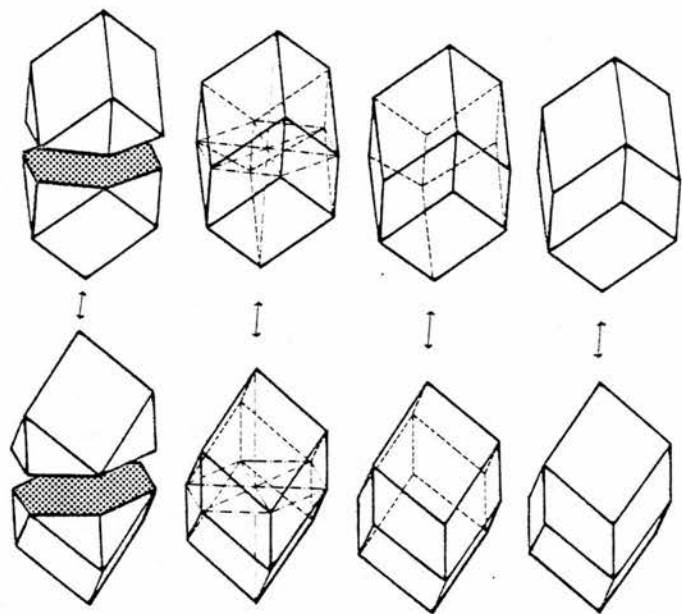


Fig. 10.27 The second prototypic double-figure

However, the most interesting way of constructing these two double-figures is to employ the cube as a generator (Fig. 10.28).

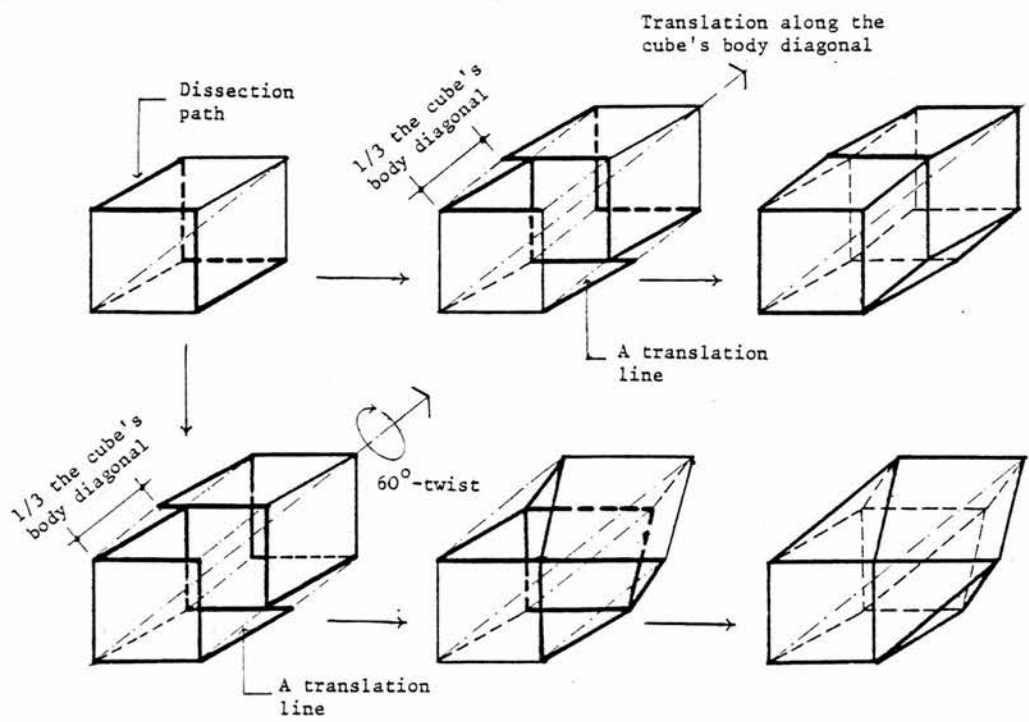


Fig. 10.28 Generating the two prototypic double-figures from the cube

Both double-figures are convex and 12-faced. Six of the twelve faces in each figure are square (the s-faces in the generating cube) and shared between two polar units each of which is formed by the orthogonal meeting of three s-faces around a polar vertex. The two polar units are separated by a central 6-faced belt made out of the remaining non-square faces.

In the first double-figure, these six faces are isosceles triangles which join alternately along their bases' edges or at their opposite 'head' vertices. Their f-angles are  $54^{\circ} 44'$ ,  $54^{\circ} 44'$  and  $70^{\circ} 32'$ , respectively. On the other hand, the d-angles in the whole figure are  $18-90^{\circ}$ ,  $6-120^{\circ}$  and  $12-125^{\circ} 16'$ , respectively, while its twenty one edges are of two classes (18 and 3 in number). They compare with those of the prototypic polyhedron and to each other as follows:

$$\ell_1 : 2\ell_3$$

$$1 : \frac{2}{\sqrt{3}}$$

$$\text{or } \sqrt{3} : 2$$

The central belt of faces in the second double-figure consists of six parallelograms (p-faces) which are congruent and join along their short edges in a zig-zagging fashion. There are two classes of f-angles in these p-faces;  $54^{\circ} 44'$  and  $125^{\circ} 16'$ . The whole figure has three classes of d-angles;  $18-90^{\circ}_{2s}$ ,  $6-120^{\circ}_{2p}$  and  $12-125^{\circ} 16'_{p/s}$ , respectively. Compared to the prototypic polyhedron's and themselves, the two classes of the twenty four edges (18 and six in number) in this second double-figure stand as follows:

$$\begin{array}{l} \ell_1 : \ell_3 \\ 1 : \sqrt{3} \end{array}$$

or  $\sqrt{3} : 1$

Both double-figures, however, singly pack the space without gaps or overlappings (Figs. 10.28 and 10.29, respectively).

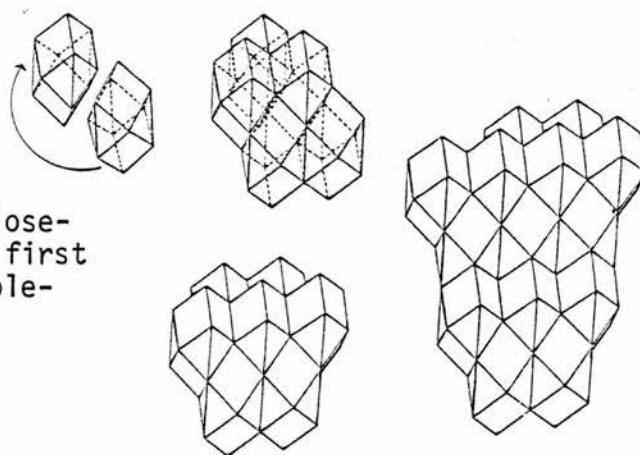


Fig. 10.28 Space close-packing by the first prototypic double-figure

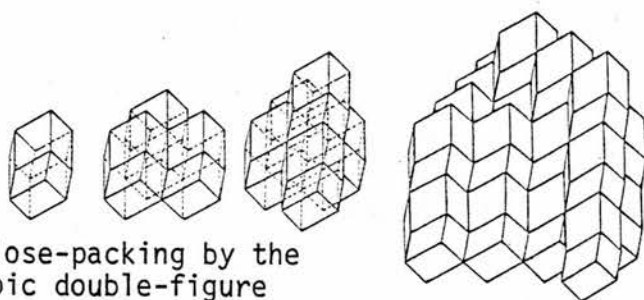


Fig. 10.29 Space close-packing by the second prototypic double-figure

Since both prototypic double-figures are 12-faced, directly originated in the cube and considerably dominated by its orthogonal characteristics, the generic term CUBO-DODECAHEDRA is suggested here as a name for the general class of polyhedra. Hence the two double-figures remain special cases of *cubo-dodecahedra*. For instance, the first double-figure is the only cubo-dodecahedron with *t*-faces. Therefore, it can be given the name TRIANGULO-CUBO-DODECAHEDRON. The second double-figure

satisfies all the requirements for defining a *parallelohedron*<sup>11</sup> and thus may be conceived of as a PARALLELO-CUBO-DODECAHEDRON. But since there can be (as will be shown below) an unlimited number of *parallelo-cubo-dodecahedra*, the second double-figure must be further differentiated. This can be done in two ways. One way is to employ the ratio between the relative magnitudes of its two standard edges. This ratio is  $\sqrt{3}:1$ , thus we may have the name *the  $\sqrt{3}$ -parallelo-cubododecahedron*. The second way of differentiation is to conceive of it as being *the standard-parallelo-cubododecahedron*. This is because like the *triangulo-cubo-dodecahedron*, these two figures represent the two 'standard' cubo-dodecahedra, in the sense that they remain the only two cubo-dodecahedra from which the prototypic polyhedron can be obtained (as an exact half) directly by a single slicing operation along

- 
11. *Parallelohedra are a special class of zonohedra (Coxeter, 1948, p.29) 12. A parallelohedron is a convex polyhedron bounded by parallelograms and whose translated replicas can be fitted together along whole faces to pack the space solidly without gaps or overlappings. Obvious examples are the cube, the hexagonal prism and the rhombo-dodecahedron. However, the fundamental theorem related to parallelohedra is attributed to Minkowski and it involves the requirement that a parallelohedron must have central symmetry as must have its faces. For further discussion and proofs, see Toth, 1964, pp.114-19.*
12. *According to Coxeter (1948, p.27), a zonohedron is defined as a convex polyhedron bounded by parallel pairs of congruent and parallel-sided faces. An important property of such a polyhedron is that it has  $n(n-1)$  faces, where  $n$  is the number of different directions in which edges occur. In the second double-figure, there are four directions in which edges occur, therefore,  $n(n-1) = 4(4-1)=12$  faces, which are, ultimately, all parallelograms. Furthermore, this double-figure has body central symmetry and also every face in it belongs to two zones which cross each other at that face and again elsewhere (at the counter face). Hence, the faces occur in opposite pairs that are congruent and similarly situated in parallel planes.*

their equatorial planes (Fig. 10.30). In fact, all the remaining

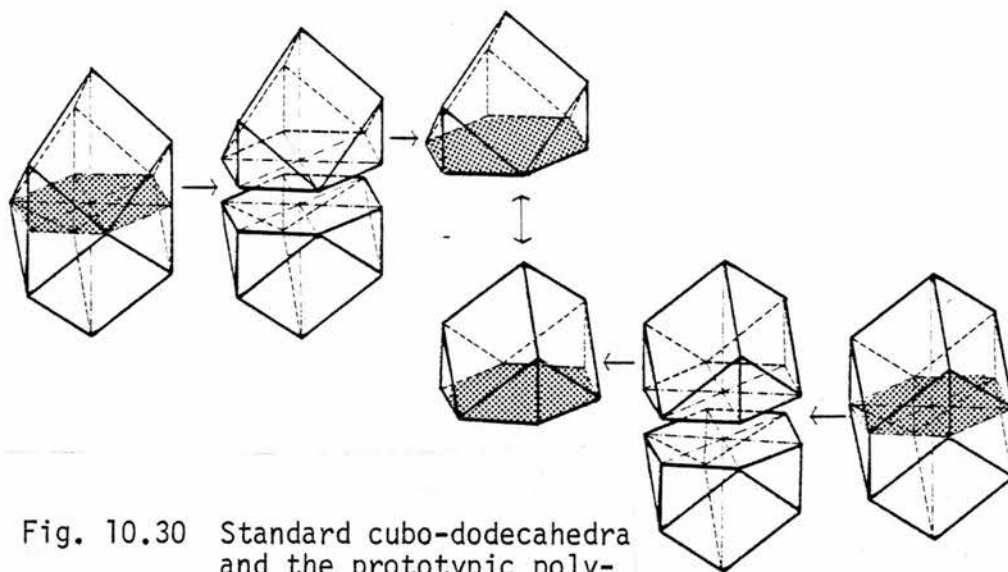


Fig. 10.30 Standard cubo-dodecahedra and the prototypic polyhedron

cubo-dodecahedra can be obtained from these two figures through a simple elongation process.

For example, the standard parallelo-cubo-dodecahedron can be easily transformed into what may be called the RHOMBO-CUBO-DODECAHEDRON by transforming its central belt of  $p$ -faces into rhombic ones, when elongating their mutually parallel co-edges from an equivalent length of  $\ell_3$  to  $\ell_1$  (Fig. 10.31). The *rhombocubo-dodecahedron* has all the characteristics of the standard

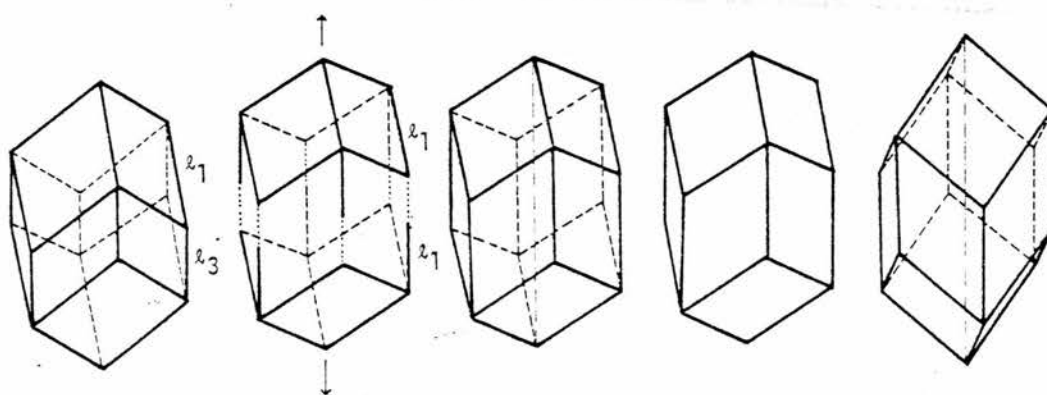


Fig. 10.31 Constructing the rhombo-cubo-dodecahedron

parallelo-cubo-dodecahedron (including its singly space-filling property), except for the fact that it is the only cubo-dodecahedron with equal edges all around and a central belt of rhombic faces.

With various variations in the elongation process above, the standard parallelo-cubo-dodecahedron can be progressively transformed into an infinite series of *elongated cubo-dodecahedra* whose two classes of edges may range in relative lengths by the ratio  $\sqrt{3}:x$  ( $0 < x \leq \infty$ ). When the process of elongation is reversed and  $x$  is made equal to zero the cube will be obtained. Thus the parallelo-cubo-dodecahedra can be *degenerately* transformed into the cube by a single 'translation' process.

In a similar fashion, the triangulo-cubo-dodecahedron can also be transformed into an infinite series of what may be termed as the **TRAPEZO-CUBO-DODECAHEDRA**. Fig 10.32 depicts one such *trapezo cubo-dodecahedron*.

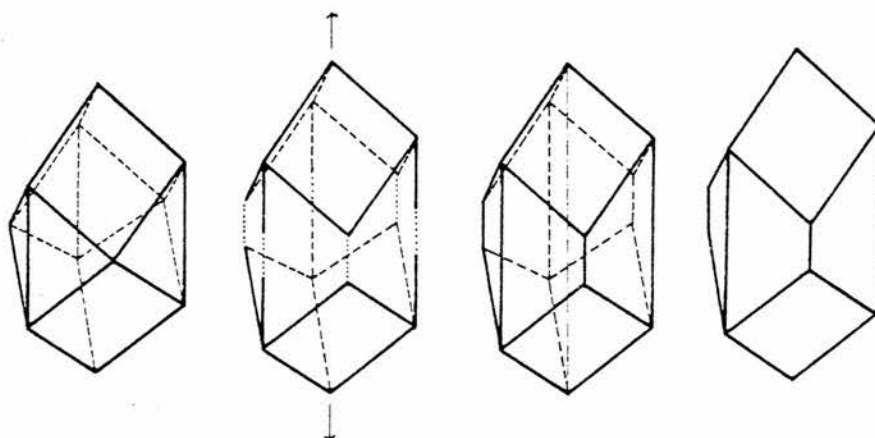


Fig. 10.32 Constructing a trapezo-cubo-dodecahedron



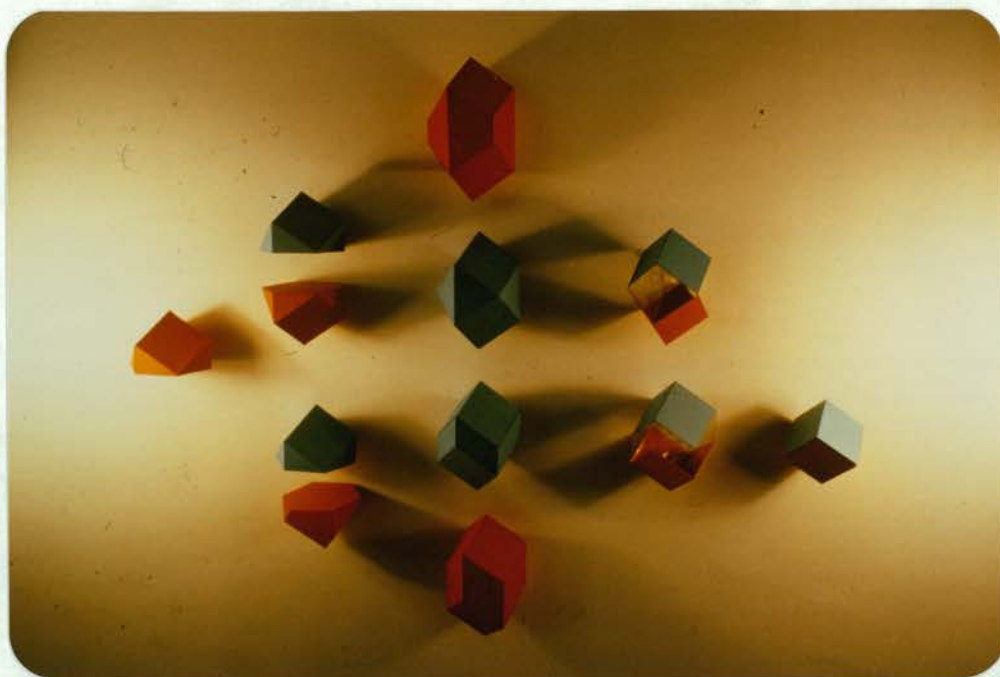


Photo. 10.3 The generation of cubo-dodecahedra

In the same way, the elongation process above can be extended to the prototypic polyhedron and its sub-cells (Fig. 10.33).

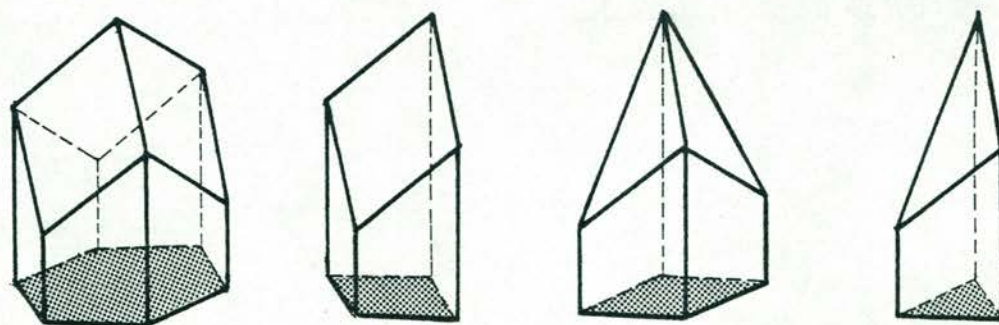


Fig. 10.33 An elongated prototypic polyhedron and its elongated sub-cells



All the elongated cubo-dodecahedra and their sub-cells are also space-filling solids. On a general level, the cubo-dodecahedra seem to bear a striking resemblance to the well-known group of figures the rhombo (standard or elongated)-dodecahedra and their twist counterparts the trapezo (standard or elongated)-rhombo-dodecahedra (Fig. 10.34). The distinction between the two groups of figures comes from the special orthogonal characteristics of the cubo-dodecahedra. But since the s-faces in the cubo-dodecahedra are rhombic (though special) faces anyway, the two groups of dodecahedra can be considered to belong to a more general class of rhombo-dodecahedra, of which every figure in the two groups become a special case of a special sub-class.

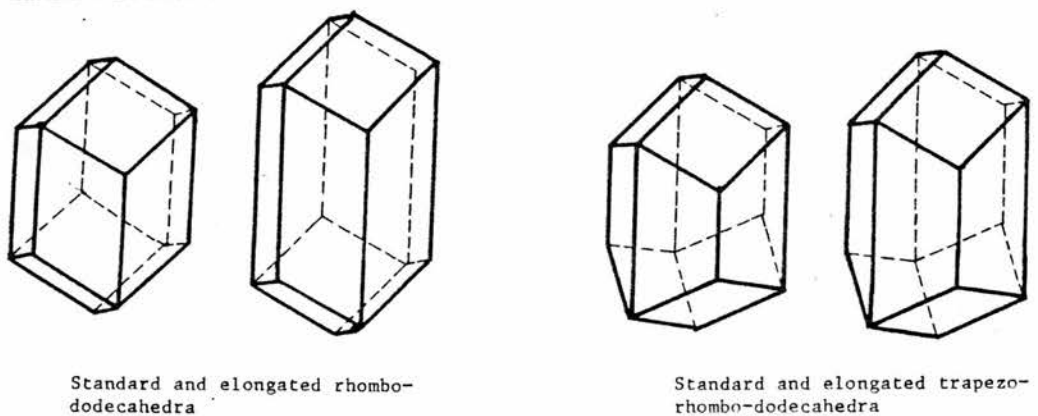


Fig 10.34

Indeed, at various levels of consideration, each cubo-dodecahedron can easily be juxtaposed on a corresponding elongated rhombo- or trapezo-rhombo-dodecahedron. One interesting result of this is that the prototypic polyhedron can be juxtaposed with half an elongated  $\frac{3}{2}$ -rhombo-dodecahedron (Fig. 10.36), in such a way that each would eventually be of help in stabilizing the other. For instance, the skeleton of the prototypic polyhedron can be regarded as acting as a

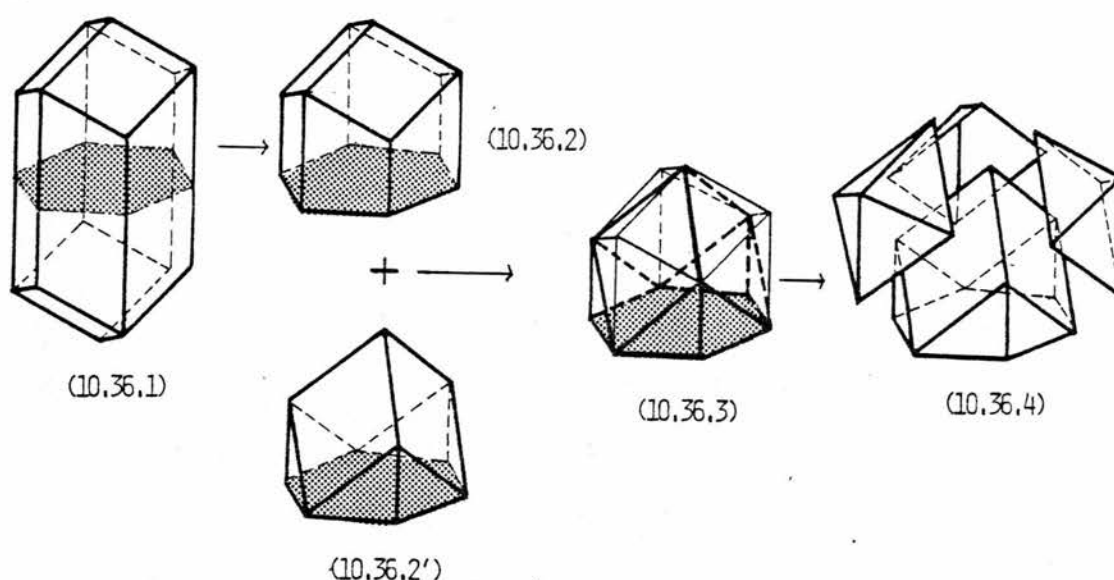


Fig. 10.36 Relating the prototypic polyhedron to half the  $\frac{3}{2}$ -rhombo-dodecahedron

*triangulator* to the faces (except the base) of half the  $\frac{3}{2}$ -rhombo-dodecahedron, while, on the other hand, the juxtapositioning of this half on the prototypic polyhedron results in mounting its s-faces with three square-based pyramidal units (Fig. 10.36.4)<sup>13</sup>.

There are, of course, many other interesting geometrical properties and features attached to this new group of cubo-dodecahedra which could be investigated. For instance, what about their truncations or stellations? What is the nature of their dual figures or the figures which inscribe them? As a representative example (see Fig. 10.37), the standard parallelo-cubo-dodecahedron can be shown to be fully triangulated when juxtaposed on the *octahedron*. These

13. Any one of these square-based pyramids is, in fact, the same as any of s-based pyramids obtained by unfolding or subdividing the corresponding generating cube into six congruent square pyramids when joining its eight vertices to its body centre. Each of these s-based pyramids will have as base one face in the cube. The edges of the base are, of course, equal to the cube's side, while the remaining edges are equal to half its body diagonal. When these six pyramids are placed on the faces of another congruent cube, the rhombo-dodecahedron results.

properties are too many to go into within the confines of the present discussion, but they provide a rich area for further research.

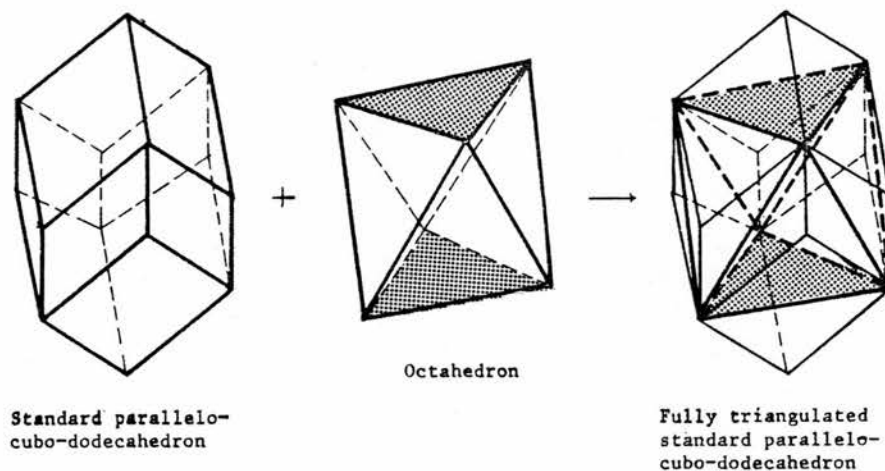


Fig. 10.37 Juxtaposing the standard parallelo-cubo-dodecahedron on the octahedron

## 10.5 PHYSICAL REALIZATION AND STRUCTURAL STABILITY

Before considering the rich spatial possibilities which the prototypic polyhedron, its sub-cells and its parent group of polyhedra give rise to, it is of value to offer a few suggestions on how the prototypic polyhedron, in particular, can be structurally stabilized and made rigid. From the outset, however, it must be emphasized that the suggestions given below are neither exhaustive nor analytically rigorous. The aim here is to give a brief orientation and a few preliminary examples of the kind of *building structure*<sup>14</sup>

14. The use of the term *building structure* in the present context is deliberate. It is intended to make a differentiation between the special conception of 'structure' as related to statics, load-bearing, resistance of forces and so on, and its general epistemological and methodological conception as has been referred to in the rest of this thesis.

systems which can be adopted and on the basis of which future investigation may be conducted.

Structural stability may be achieved by geometrical arrangement or strength of materials. In reality, a building structure always involves both. But within this, it tends to take more advantage of one than the other, for a variety of reasons. Initially, however, it is always preferable to take advantage of geometrical arrangement with the aim of saving on materials and space. Indeed, the significance of geometrical arrangement is far reaching: it imparts strength to the structure even before the detailed physics and bulk of materials is taken into consideration.

In relation to the prototypic polyhedron, therefore, the building structure systems which are favourable for adoption are either vector-active (i.e. strutted structure systems which are in co-active tension and compression), surface-active (i.e. multi-faced structure systems in surface stress condition) or any combination of these<sup>15,16</sup>. The behaviour of both systems or their combinations is largely governed by the basic principles of geometric stability. To be inherently stable, strutted systems depend on full

15. See Engel (1968), for an informative discussion on building structure systems, generally. See also Crapo (1979) for a rigorous summary of the theory of structural rigidity of 3-dimensional structures.

16. This does not mean that, for instance, bulk-active systems (i.e. structure systems in bending) cannot be used to structure the prototypic polyhedron, but because of their high material content and the amount of space they tend to occupy, they are clearly less favourable.

triangulation<sup>17</sup>, while surface-active systems depend on complete boundedness by surfaces (Pearce, 1978, p.138). Both conditions, however, are not always a necessity for the achievement of structural stability. There are situations which when involved in a structure may result in its structural stability without undergoing the elaborate processes of full triangulation or full surfacing. Such situations may arise from, for instance, smallness of scale, the necessity of involvement of building materials in the physical realization of the structure and most significantly some favourable geometrical distributions of particular members of the structure itself. For example, with six t-faces and by fixing in position the six joints which lie in the floor plan<sup>18</sup>, the strutted prototypic polyhedron can be expected to remain stable at a reasonably operative scale without the introduction of major extra reinforcement.

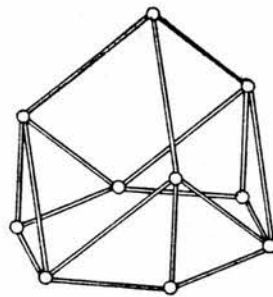


Fig. 10.38 Strutted prototypic polyhedron

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17. "Stable structures are not necessarily triangulated polyhedra, for there are numerous internal struts that will stabilize a structure without making it a triangulated polyhedron. However, triangulated polyhedra have now been proved to be stable structures." (Loeb, 1976, pp.34-35). (For detailed proofs, see the same reference, Chapter 6).

18. Though with the risk of extra loading at these joints.

Nonetheless, as it is, the prototypic polyhedron cannot be expected to adequately satisfy the range of stability and rigidity conditions which must be met with increase in size. Hence additional strutting will be required (for example, Fig. 10.39) up to the level of full triangulation. There are, of course, many ways to achieve this (for instance, Fig. 10.40), but (as observed earlier) one interesting possibility involves inscribing the prototypic polyhedron with a tetrahedral skeleton (Fig. 10.41).

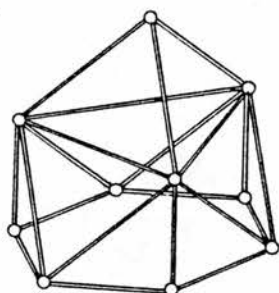


Fig. 10.39 Additional facial strutting

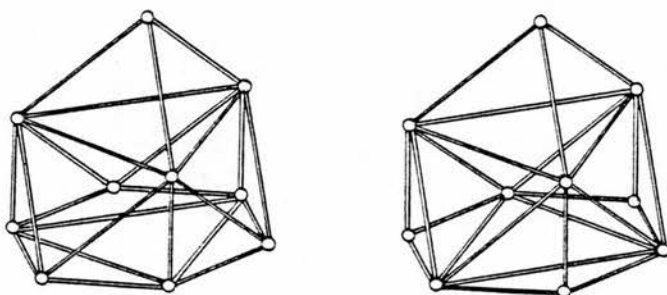


Fig. 10.40 Two ways of full facial triangulation

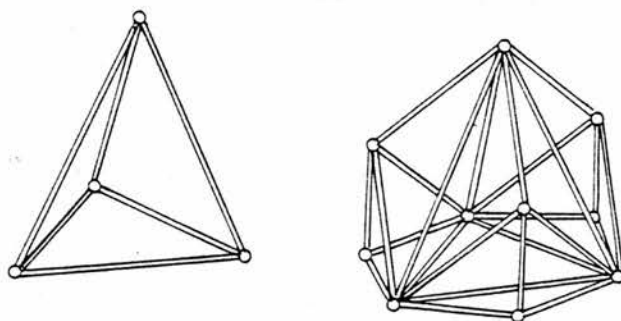


Fig. 10.41 Full facial triangulation by inscription of a tetrahedral skeleton

Nevertheless, even when fully triangulated, a structure will start to be progressively unstable, when its struts become too long to resist buckling. Therefore, further elaboration of the triangulation process may need to be introduced. Two examples of further triangulation elaborated on the roof unit are shown in Fig. 10.42.

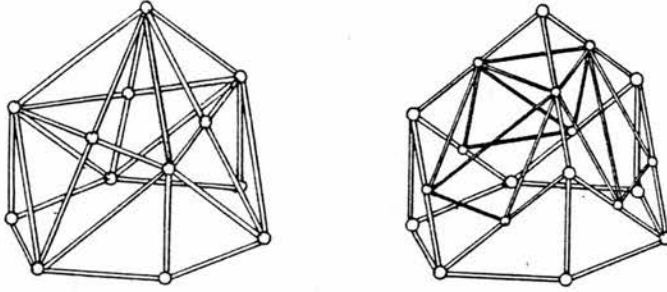


Fig. 10.42

Except for a large size, therefore, it is possible to substitute a simple layer of vector-active triangulation for a continuous surface, giving a family of triangulated analogues to the elementary shape of the prototypic polyhedron. But as triangulation in one plane gives a form analogous to slender, though relatively solid, surfaces, there will be a tendency for surfaces to be compoundly prone to bending and buckling out of their planes. And with further increase in overall size, this becomes definitely so. Hence, there is the fundamental problem of eliminating the risk of buckling and bending, either involving the whole structure or confined to local deformations.

According to Pearce (1978, p.191), there are two main ways to deal with this condition. Only one method allows surfaces to remain planar. This is accomplished by creating double-planar space-frame structures. The shapes of the faces so structured will,



of course, influence the geometric arrangement of these space frames. The second method is to mount these faces with non-planar (convex or concave) arrangements, including trusses, folded-plates, hyper and domical surfaces, and so on. This, of course, results in a rapid reduction in the flexibility of joining space-cells to each other.

Now, as far as the prototypic polyhedron is concerned, the major source of structural instability may arise with the roof unit, because of its undeniably cubical nature. Cubical or prismatic shapes, though they are the most popular shapes used in architectural design, are inherently lacking in structural stability, especially when compared with triangulated (in particular fully triangulated) ones (Fuller, 1975; Loeb, 1976; Pearce, 1978). Hence in the following examples the main concern will be with suggesting possibilities for stabilizing the roof unit.

Before extending the application of space-frames, folded plates and so forth, there are still some intermediate ways which perhaps could be employed to achieve structural stability, while keeping the external space of the prototypic polyhedron completely unaffected. At the roof level, for instance, internal cross-ties, cross-trusses or transversally interlocking surfaces (Fig. 10.43) may be of use, so long as the enclosed space remains functional by maintaining sufficient ceiling heights.

As regards the external space, whatever additional structuring arrangement is employed, there is an important restriction which must be complied with if a minimum level of flexibility in joining



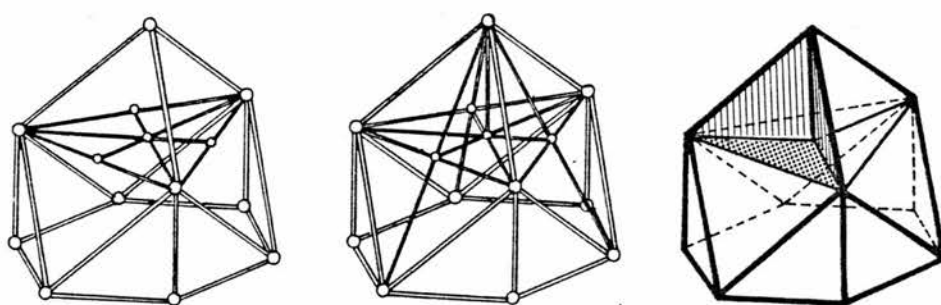


Fig. 10.43

prototypic units is to be maintained. This restriction refers to keeping entirely clear all the spaces outside the infinitely elongated, hexagonally prismatic surfaces surrounding the prototypic polyhedron (Fig. 10.44). In this manner, the vertical planes along the t-faces remain flat and thus free to join with their similars in other prototypic units as the need arises.

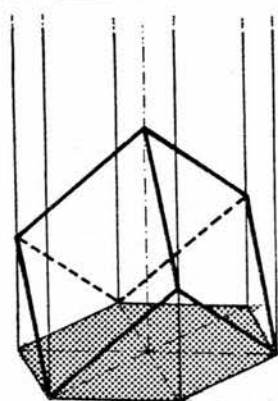


Fig. 10.44

Within this restriction, for instance, different stratified (double or more) roof layers can be created (Fig. 10.45). These layers may be filled in a variety of ways by space-frame structures,

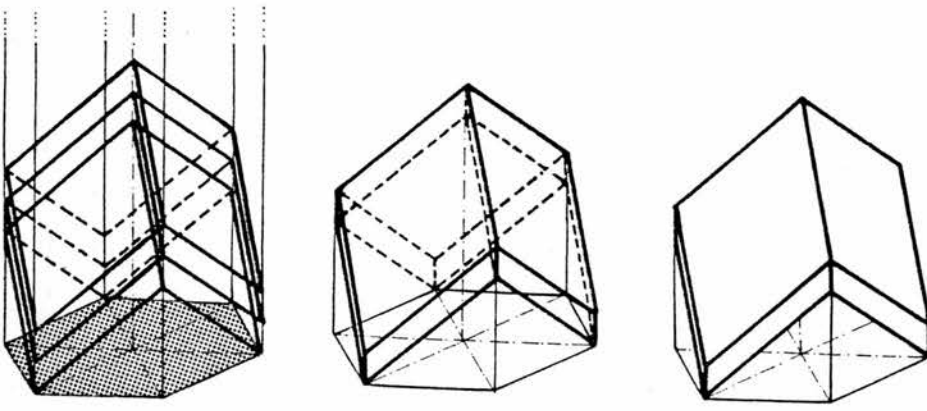


Fig. 10.45

and so on. In fact, as a simplification of this, each face in the roof unit can be considered within the confines of its vertically enclosing infinitely elongated, rhombic prismatic planes (Fig. 10.46). The way it is structured, then, can be repeated on the other faces within the context of the whole prototypic unit.

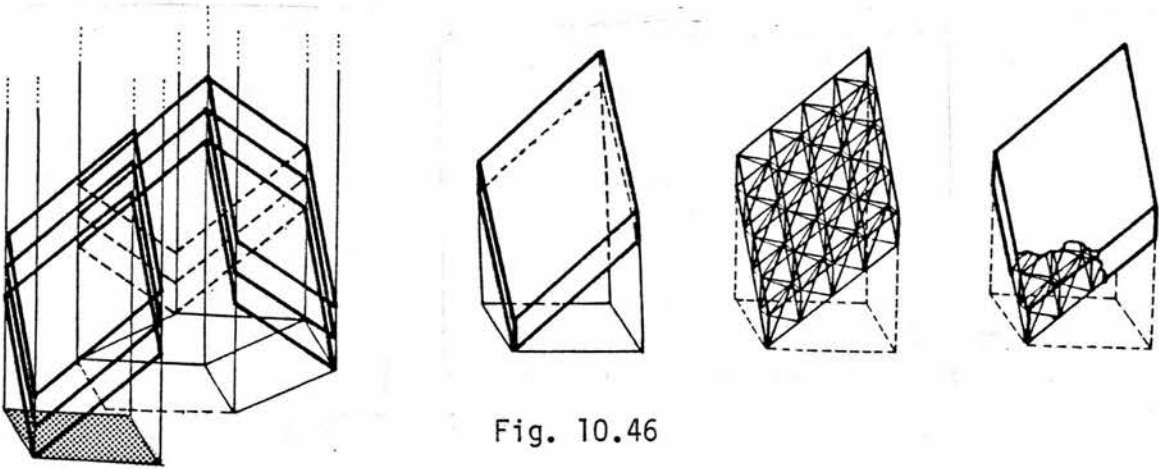


Fig. 10.46

Obviously, there can be many ways of developing double-planar space-frames to fit to the roof faces, but an interesting possibility is to develop space-frames which employ small replicas of the partially (or if need be fully) triangulated prototypic polyhedron as their basic space sub-units. This is not difficult to realize, since the prototypic polyhedron and its sub-cells have already been shown to be space-fillers. Fig. 10.47 does not represent a fully developed prototypic space-frame structure, but it is indicative of its possibility. Thus the prototypic polyhedron can be of use

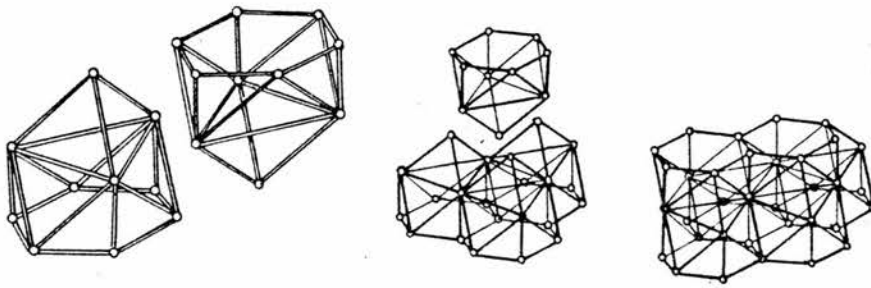


Fig. 10.47

in organizing a geometric arrangement which is functionally useful spatially and at the same time offer a feasible opportunity for generating space-frames which can be employed for stabilizing this functional space structurally.

In terms of non-planar structural arrangements, Fig. 10.48 suggests a number of options on folded, hyper or curved surfaces including, for instance (Fig. 10.49), the mounting of the square-

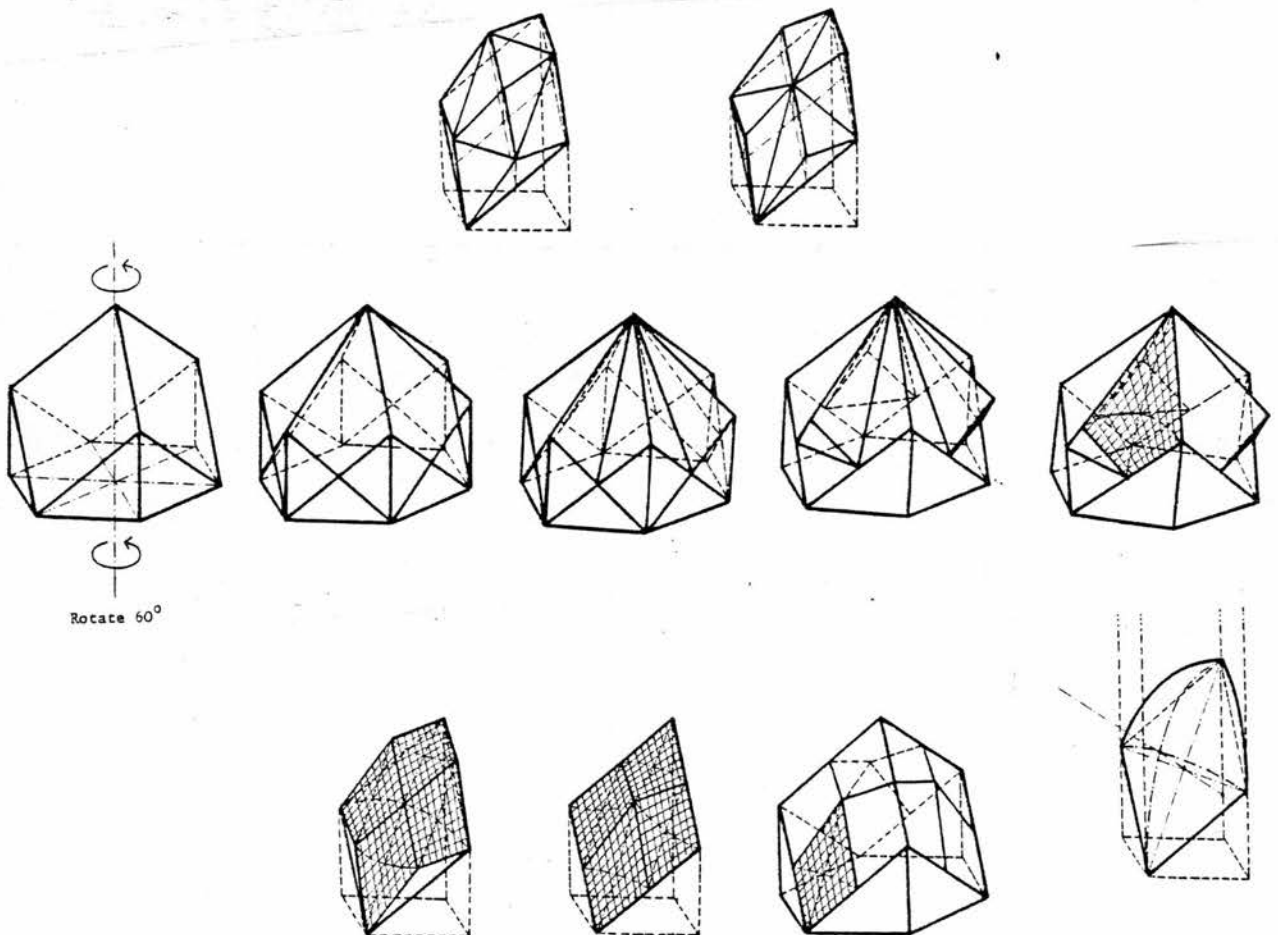


Fig. 10.48

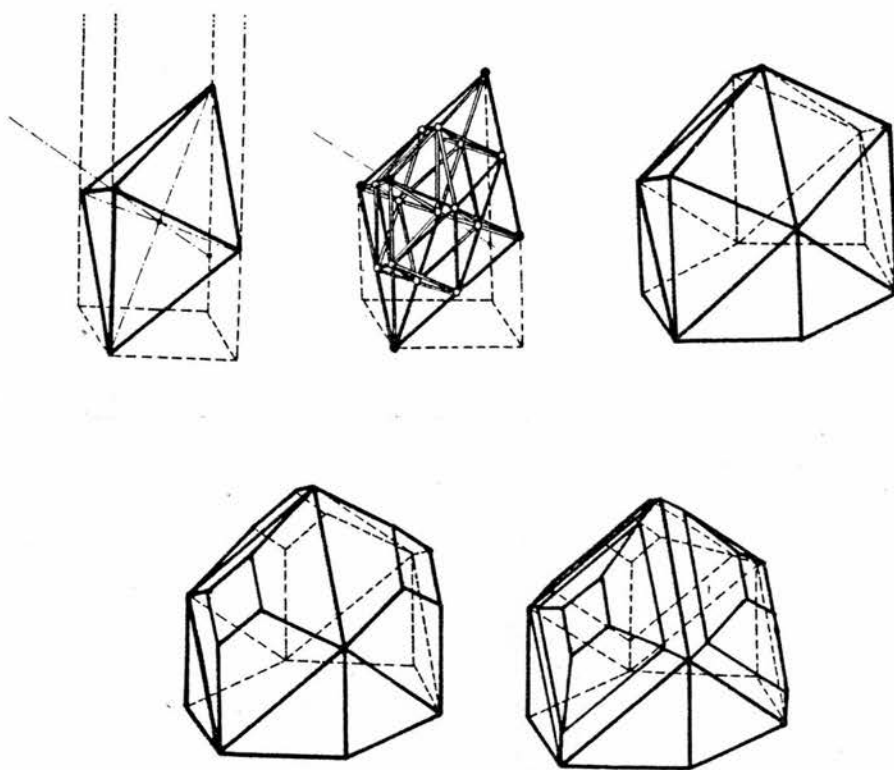


Fig. 10.49

based pyramids obtained by juxtapositioning half the elongated  $\frac{3}{2}$ -rhombo-dodecahedron which has been referred to in the previous section (p.257). These pyramids can be arranged in the form of folded surfaces or trusses, and also transformed into singly or doubly truncated ones.

With curved arrangements, the possibilities may include domical roof tops (for instance, Fig. 10.50) or ultimately (when the above hexagonally prismatic restriction is ignored) the full development into geodesic domes. Fig. 10.51 depicts the main great circles on which the vertices of the prototypic polyhedron lie. This offers an initial connection between the prototypic polyhedron and any geodesic domes based on the  $\frac{2}{3}$ -sphere in which it sits.

The examples given above on structural stability may be either over-simplified or too general, but they illustrate the wide range

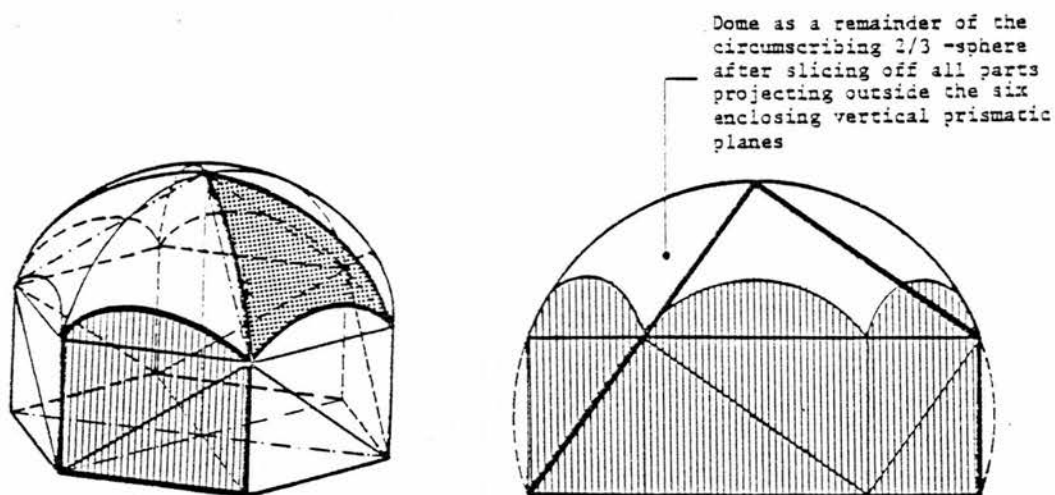


Fig. 10.50

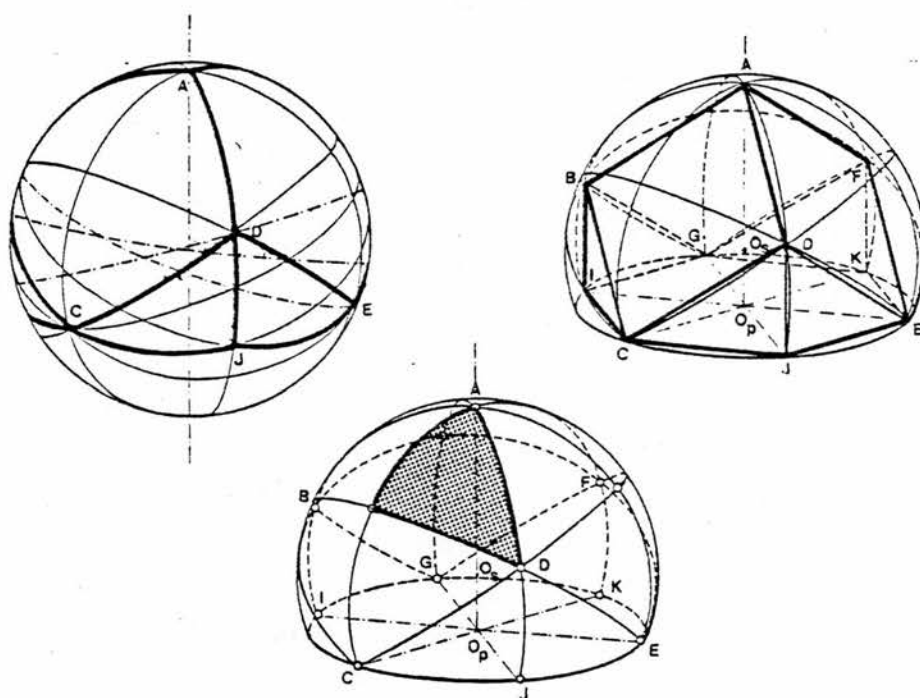


Fig. 10.51

of options which are open to prototypes based on the prototypic polyhedron in order to secure their structural stability and maintain their flexibility to suit requirements of size, materials, technology and structural economy. This is the more so, when the multiplicity of spatial arrangements the prototypic polyhedron, its sub-cells and parent group allow are also considered. The following section offers some illustrative examples.

## 10.6 SPATIAL ARRANGEMENTS AND CONFIGURATIONAL POSSIBILITIES

The first set of possibilities in the spatial configuration process are those limited to *properly combining*<sup>in</sup> units of equal size while maintaining planarity at the floor plan level. Within these adjacency restrictions, a multiple series of floor plan layouts can be elaborated on regular hexagonal grids and with a variety of different adjacency requirements (Fig. 10.52). This might also involve an equally varied series of hexagonally distributed courtyards (Fig. 10.53).

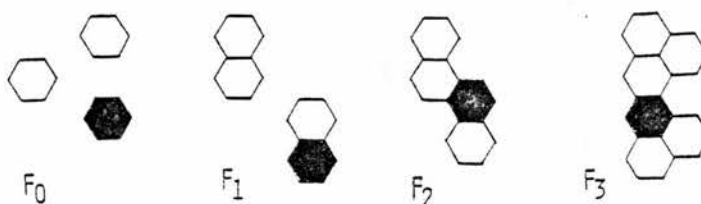


Fig. 10.52

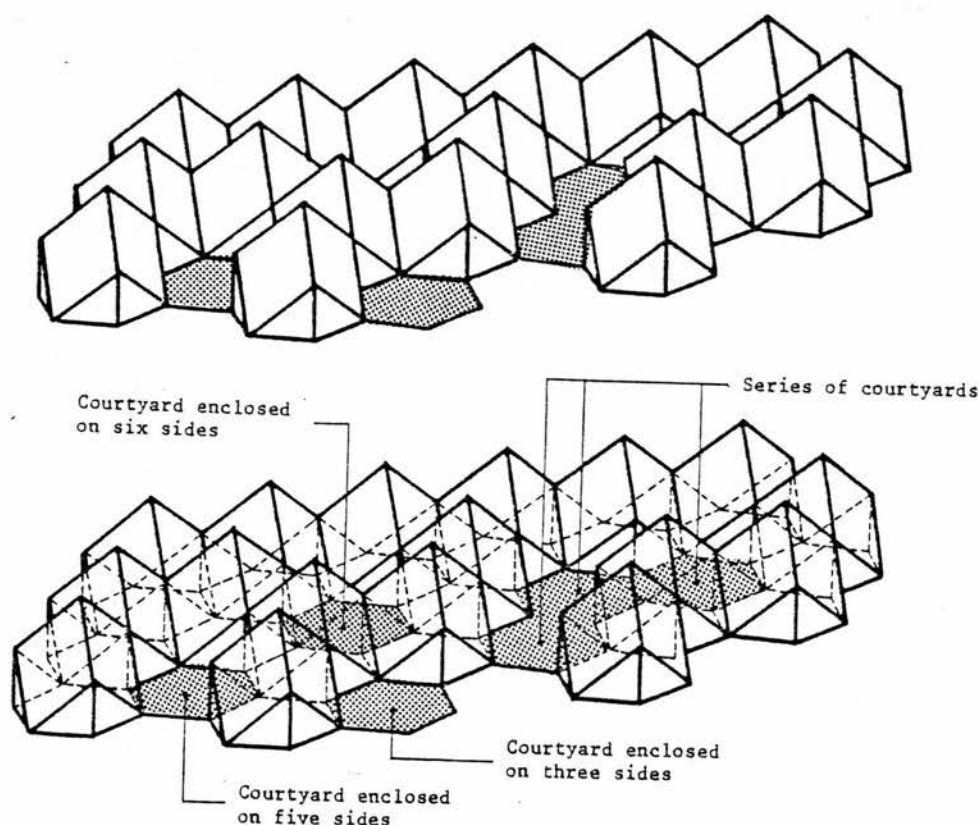
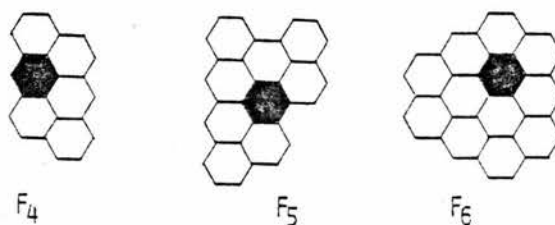


Fig. 10.53

However, the adjacency restrictions laid down above are unnecessarily strict. Once they are relaxed through change of levels of assembly, elongation, variation in size, overlapping, nesting, truncation, and so on, an almost endless universe of spatial possibilities emerges. The following series of self-explanatory examples is intended simply to give an impression of the richness of possibilities.

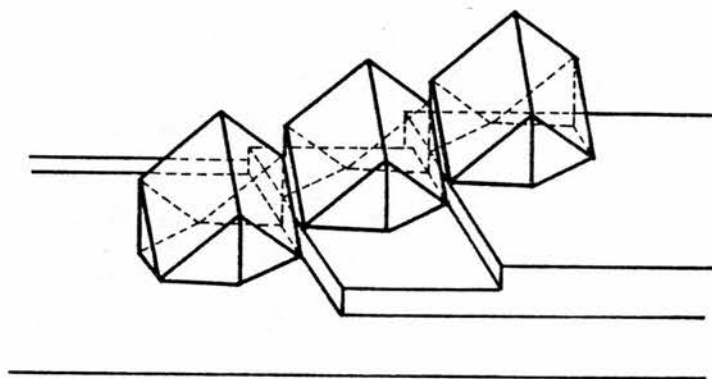


Fig. 10.54 Stepped joining

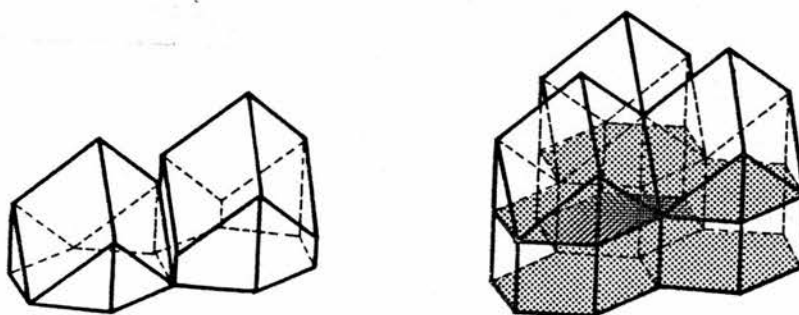


Fig. 10.55 Joining with elongation

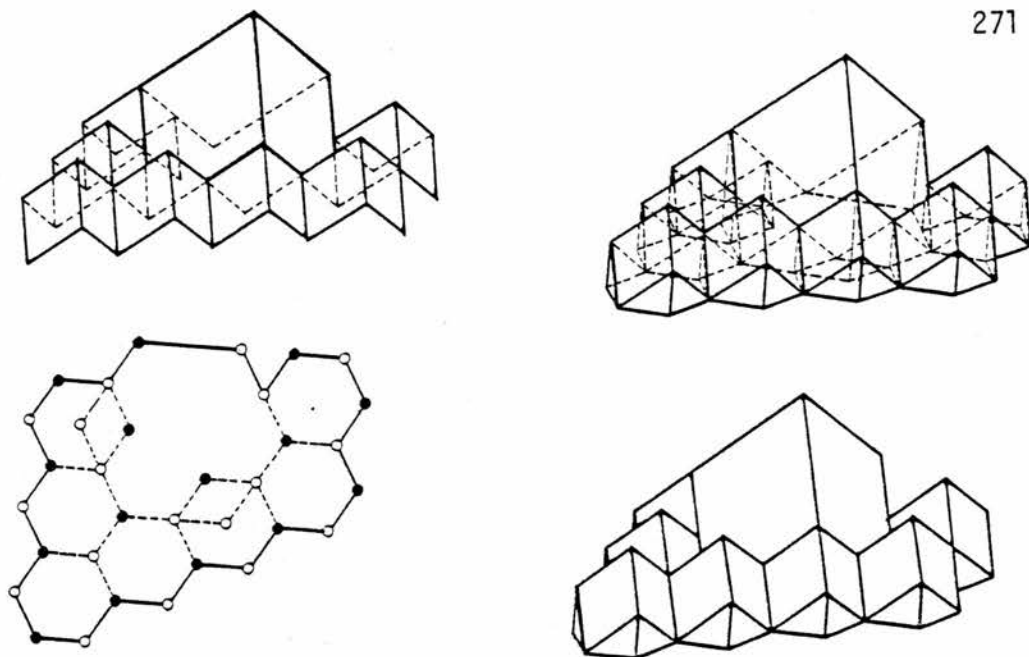


Fig. 10.56 Joining with 1:2-frequency

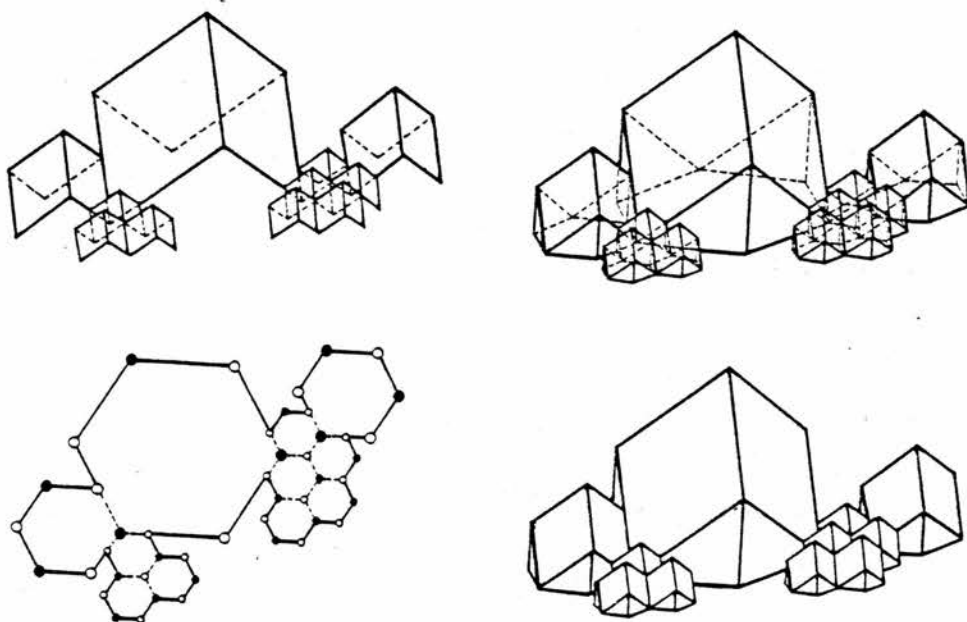


Fig. 10.57 Joining with 1:2:4-frequency

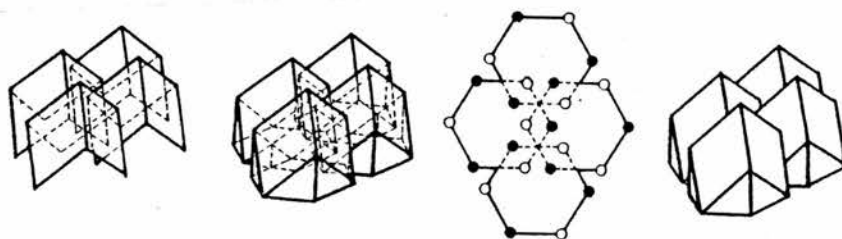


Fig. 10.58 Overlapping with 1-frequency sizes



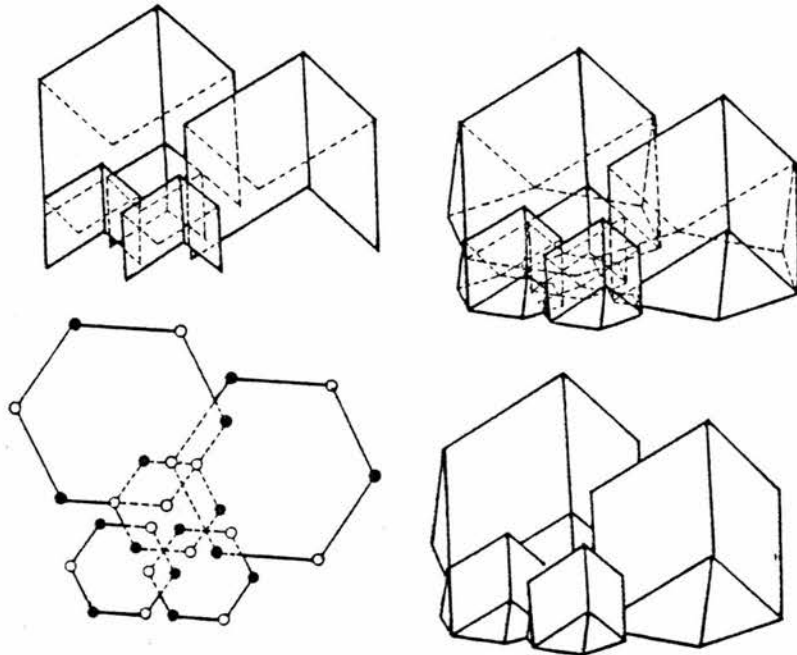


Fig. 10.59 Overlapping with 1:2-frequency sizes

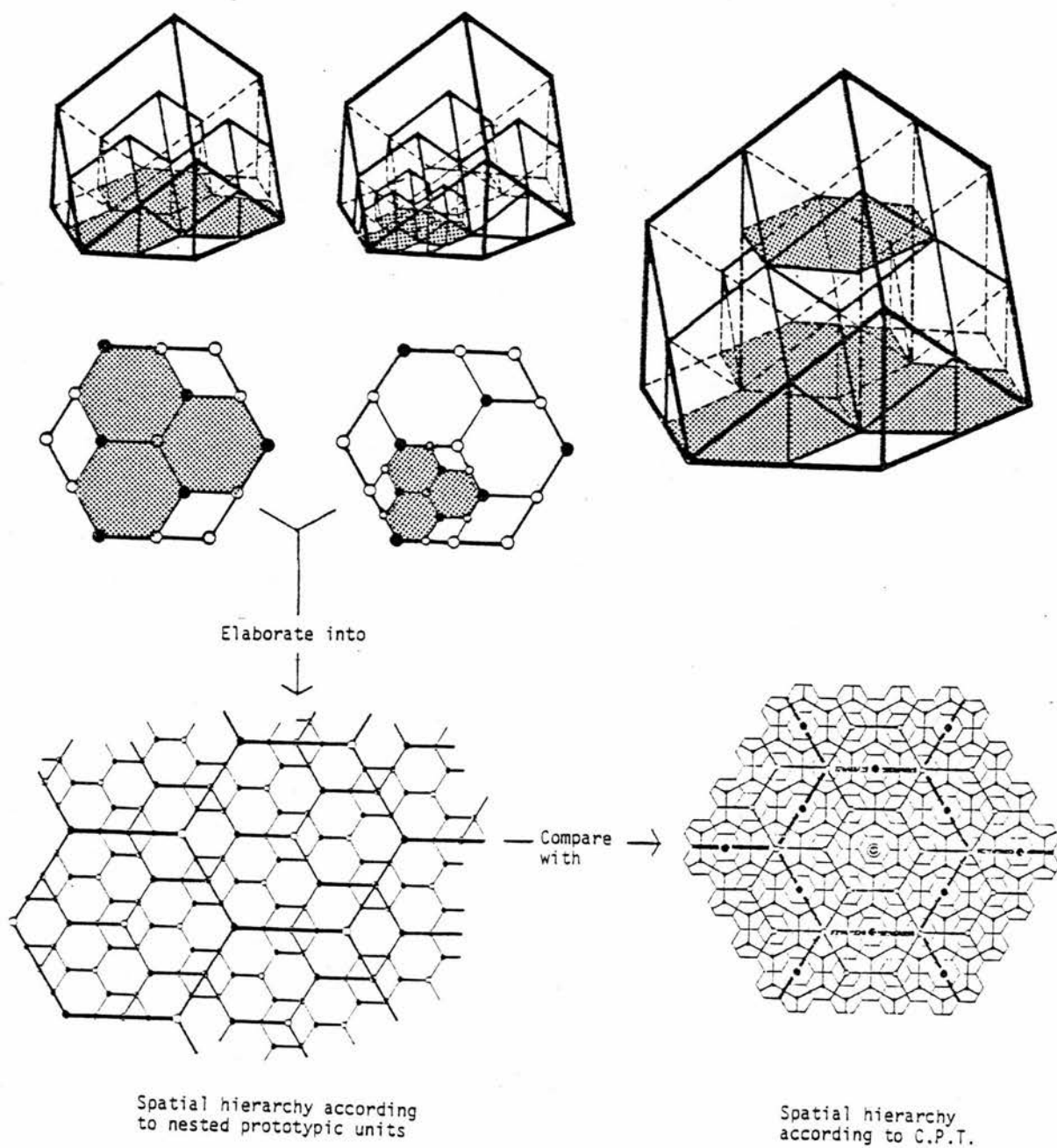


Fig. 10.60 Hierarchic single and two storeys nesting

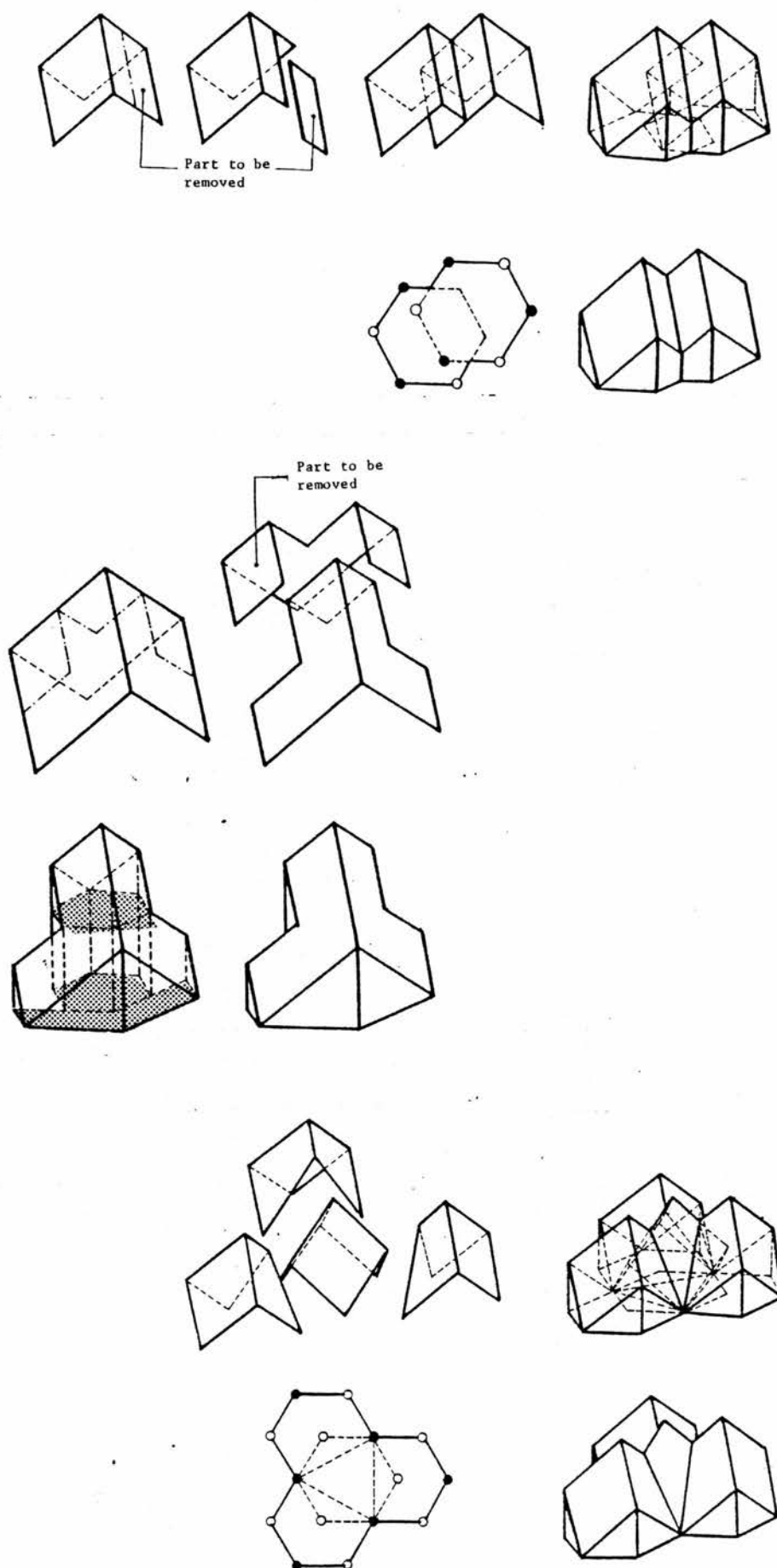
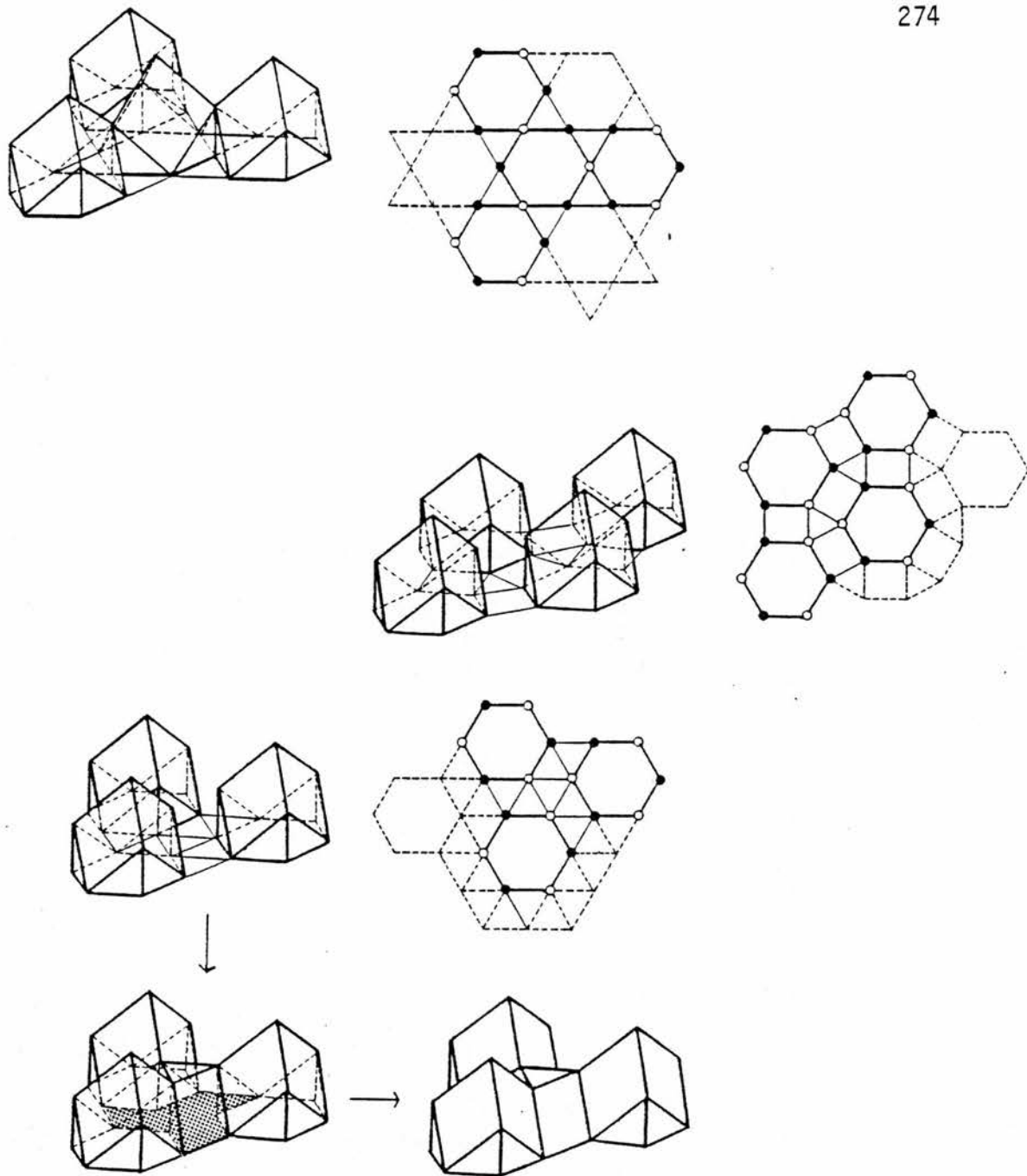


Fig. 10.61 Different ways of truncation and overlapping



10.62 Distribution on semi-regular plane tessellations and creation of different types of passages

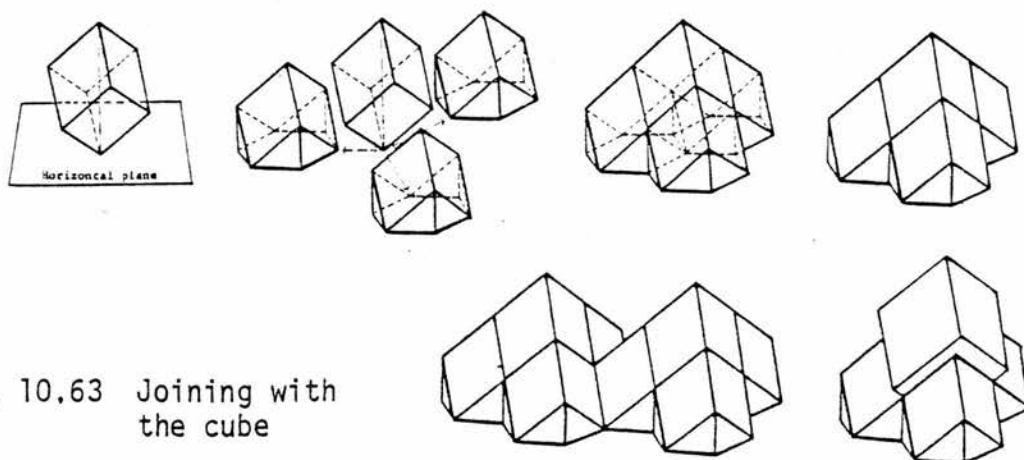


Fig. 10.63 Joining with the cube

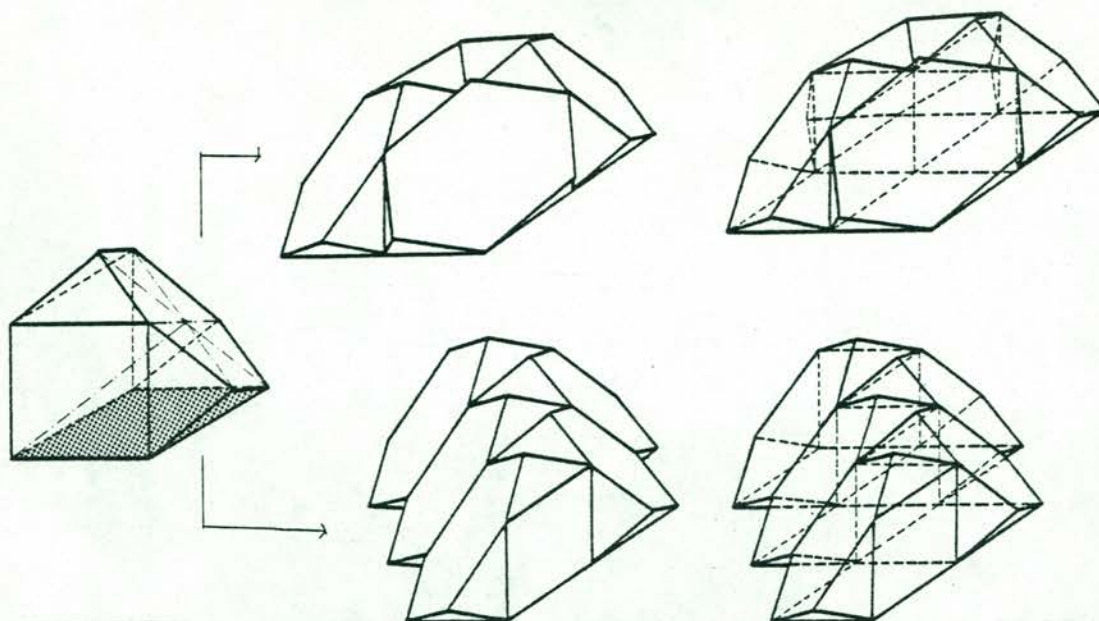


Fig. 10.64 Resting on an s-face

When the process of combination is extended to involve the prototypic polyhedral sub-cells and the prototypic polyhedral parent group, the richness of spatial possibilities goes beyond any reasonable attempt to illustrate it. A quick look at the following photographs and the graphical supplement (Appendix III) is sufficient to indicate that the range of possibilities which is opened up verges on the infinite.



Photo. 10.4



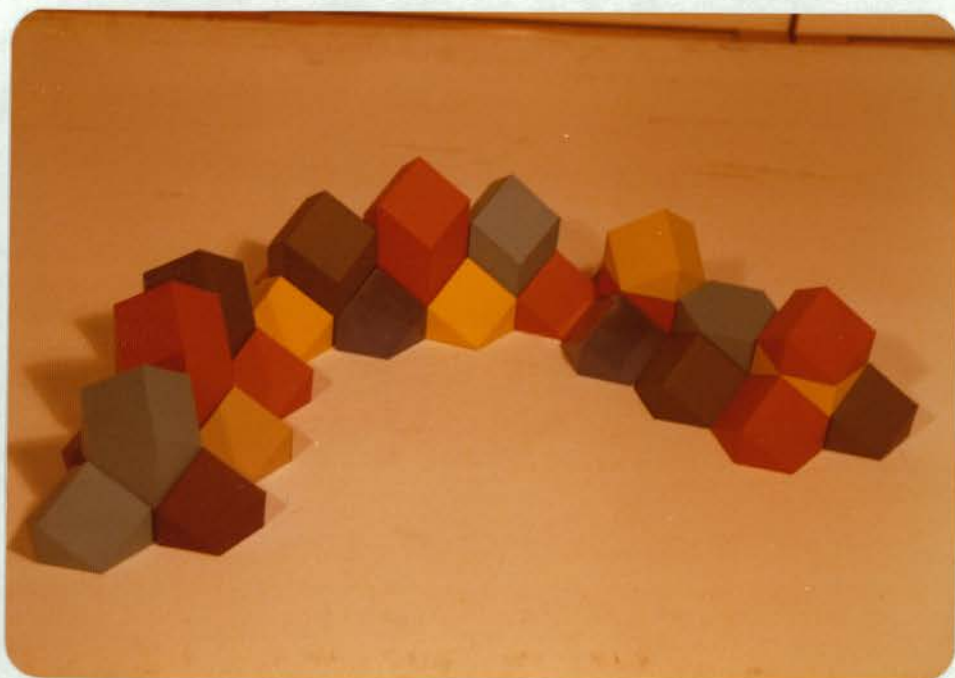


Photo. 10.5

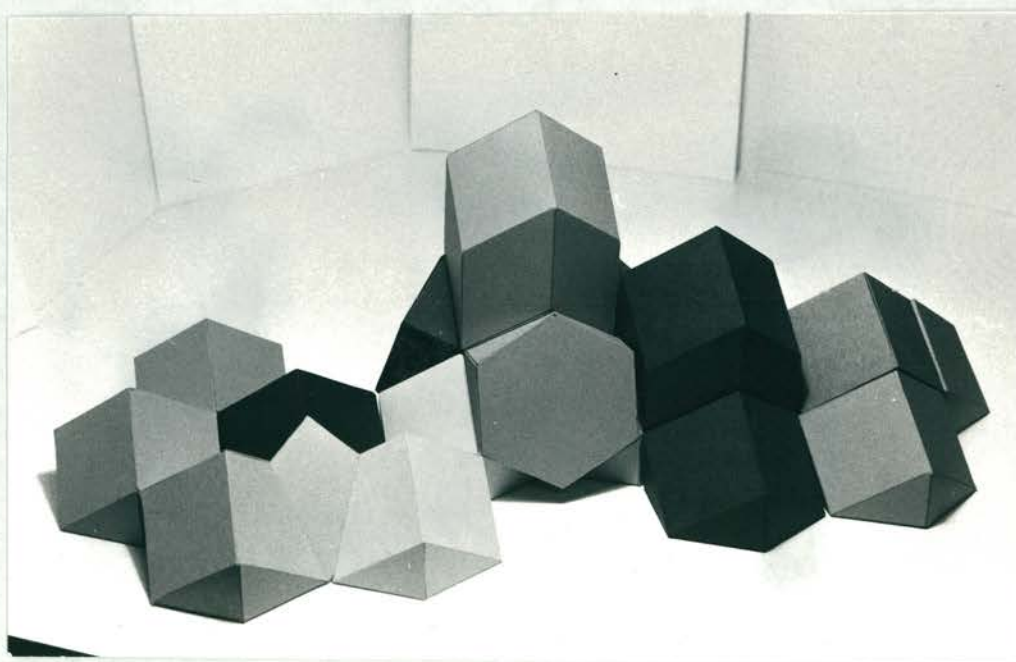


Photo. 10.6

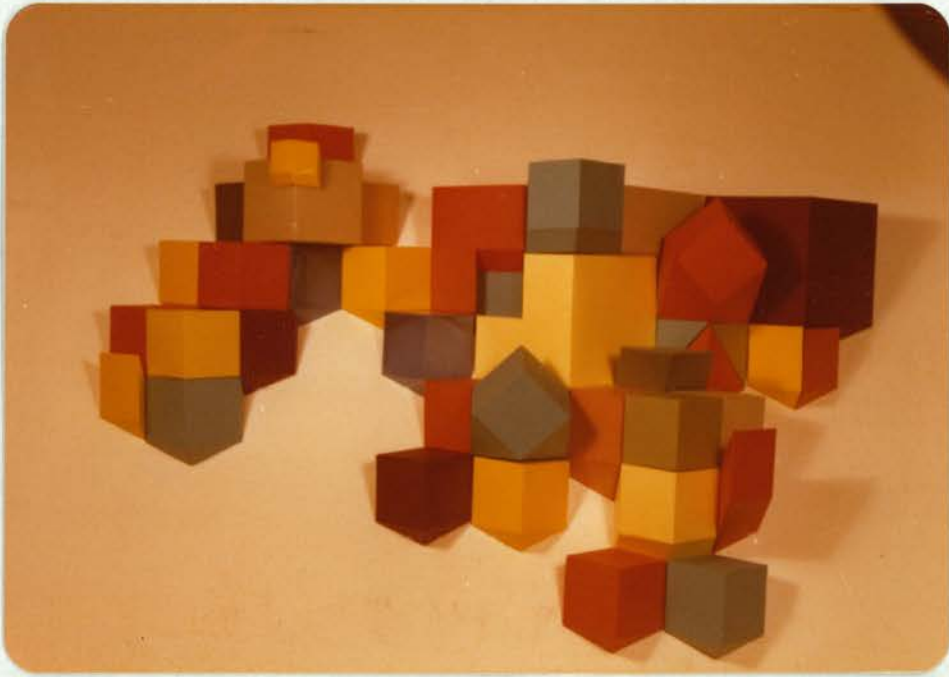


Photo. 10.7

## 10.7 CONCLUSIONS

This chapter was designed to give the first rudiments of a design-specific prototype whose further development would constitute a long-term research project. As an initial step towards its architectural realization, the envisioned prototype has been given a generic centre by allowing it to inhabit and progressively evolve within the constraints of the so-called prototypic polyhedron, involving also its space sub-cells and parent group of polyhedra. The prototypic polyhedron has proved to be at once space-defining and physically feasible. Many varied and rich spatial possibilities are found to arise. Yet, the examples given do not begin to exhaust the range of possibilities which exist and are available for architectural elaborations. Nevertheless, what has been derived above can only serve as 'raw material' for a much

more comprehensive architectural undertaking. Whatever the merits of the approach developed in this chapter, it remains a partial one, being evolved almost within the confines of one descriptor. It is far from being adequately *syntagmatic* in the sense in which the syntagmatic approach has been argued in the earlier parts of this thesis. In view of this, therefore, it would be premature to confer the full status of prototype on the prototypic unit and its extensions. What has been evolved here should be viewed as part of what might be called the *pre-prototypic stage*. It is a necessary stage. But beyond it, it is obviously important to allow the envisioned prototype to have time to evolve, before its real architectural worth can be fully realized, increased or properly evaluated. This will unavoidably involve extensive experimentation or if possible practical design applications. Both, however, remain part of the long-term research strategy.

The objective which such a long-term project is meant to serve is in compliance with the argument advanced and expounded in more than one place in this thesis. This argument has repeatedly emphasized that when the majority of designers (if not all) attempt to solve design problems (in their normal design practice), they employ already structured (new or old) architectural prototypes; prototypes which are manipulable and intelligible to them and which form a highly significant aspect of their operational architectural knowledge. It should be then a prime objective for research to equip them with a well-understood and structured vocabulary of these prototypes.



It is hoped that the account given above, will make a useful contribution to this objective. In a sense, the main usefulness of this account lies in the general logic with which it characterizes an elementary geometric figure, identifies its close link with several others and goes from there to establishing its potential for supporting an increasingly complex content. The essential question which now remains is the following: Given the spatial properties and flexibility of the prototypic polyhedron and its extensions, how prototypically architectural can it be made to be? This, of course, will depend on how responsive it is within an institutional, environmental and activity context. This, then, provides a sound basis for future investigation. In terms of environmental research, for instance, some areas suggest themselves almost immediately:

1. The investigation of distribution of thermal loads on the surfaces of isolated prototypic units or complexes of them in different climatic conditions.
2. The investigation of distribution of wind flows and the possibility of relating this to problems of sand accumulation in desert conditions, snow accumulation in arctic conditions or more generally to the micro-climate produced in the inter-building spaces.
3. The investigation of the use of roof panels as solar collectors. With a natural inclination of  $54^{\circ} 44'$  of roof panels, they might be suitable for use in particular climatic areas, especially temperate ones, where the optimum inclination of



solar collectors may approximate to such an angle.

4. The investigation of the closely linked problem of openings and fenestration.

And so on.

Another important area of research is to investigate what building types, say, housing, schools, public halls and so forth, which are suitable for such accommodation. In this context, it is worth remembering, once again, that the whole idea has originated with a school design project and, therefore, the feasibility of this particular building type should pose few problems. The question of building materials, their economics and high or low level of technology required is an equally important one to explore.

It is also possible to investigate how alien or not the prototypic shape is to certain cultures. For example, in African cultures, where all sorts of huts have been used, this shape may be potentially acceptable. In fact, in Sudan, the traditional hut shape of a circular plan and conical roof has been increasingly displaced in some areas (especially where new types of furniture have been introduced) by a square-based and pyramidally-roofed hut. This new type of hut seems to come much closer, at least aesthetically, to the prototypic shape (Fig. 10.65).

Nevertheless, at this stage, the idea that a prototype based on the prototypic polyhedron - or indeed any other new prototype - can be said to be potentially acceptable to a particular society

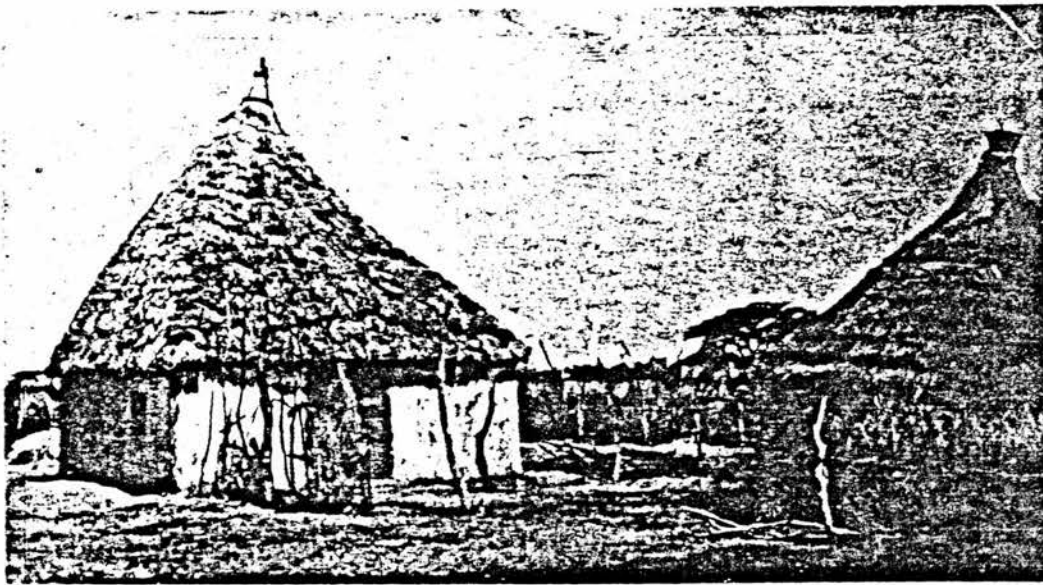
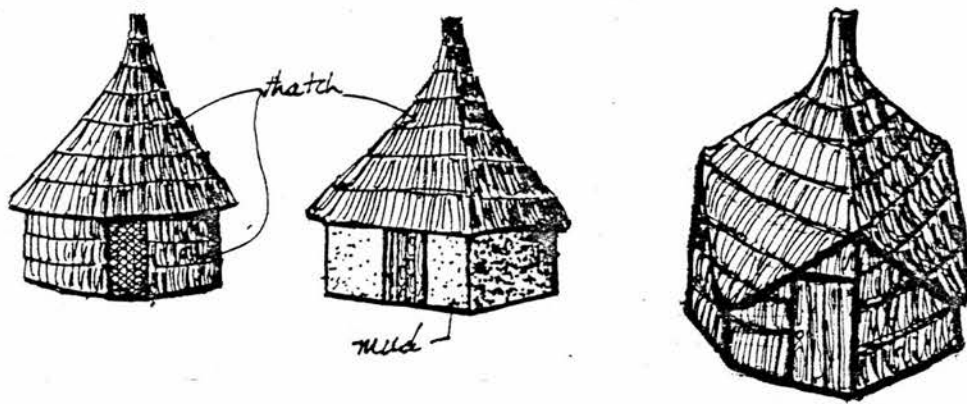


Fig. 10.65

(especially in a conservative one, like the Sudanese), can only be a speculation. It is quite difficult to say, from the outset, what cultural inhibitions a particular society will impose on accepting a generalized idea like the one presented here. Therefore, it is of the utmost importance to enquire, in detail, into the levels of its cultural adaptability within the confines of specific cultural contexts, before any conclusive statement about its viability to solve particular design problems in relation to any particular society is to be made. This, obviously, is a chief requirement under the syntagmatic framework, that is the incorporation of the cultural dimension within the object of investigation, whether this relates to prototypes or architecture generally.

## GENERAL CONCLUSIONS<sup>\*</sup>

1. A persistent theme throughout this thesis has been the search for an appropriate conception of a methodological framework through which it would be possible to investigate architecture in its totality with a view to influencing its practice. There is no claim here that such a framework has emerged in sufficient detail to warrant its formalization. Obviously, this is not the sort of framework which could be expected to be fully produced within the time-scale of a PhD thesis. Nevertheless, some important aspects of such a framework have been identified and their architectural validity investigated. The following is an abstraction of the main arguments related to these aspects.

2. It is a firm conclusion of this thesis that the fundamental problem with architectural research is a theoretical one. It is the increasingly weakening architectural basis of the theories which guide this research which is at the root of its commonly acknowledged inability to produce operational knowledge. Instead of presenting a unified all-embracing view of architecture, theoretical formulations have tended to present themselves as isolated models and techniques largely imported from other disciplines, but usually at

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<sup>\*</sup> *Each chapter in this thesis has been provided with a set of conclusions. These conclusions can be referred to in order to complement the following general conclusions.*

the same time excluding the epistemological basis of what they import from critical analysis.

3. As a first step, therefore, theoretical formulations should reflect a dual concern. The first is to maintain a high level of architectural identity; the second is to address questions of practice at the very basis of their formulation. The close link between theory and practice is in the nature of architecture itself, since it is not only a method for describing the built environment, but also a practice for producing it.

4. This is not to deny the contribution of other disciplines or to believe this contribution can be managed without when dealing with such a complex system as the built environment, but to insist that the contribution should evolve within an architectural context.

5. This introduces the requirement for a comprehensive structural framework which besides being relevant to the description of the built environment as such is also concerned with the operational character and problem-solving capacity of the descriptive tools it employs and eventually in the knowledge it produces.

6. A framework of this kind is termed (borrowing the term from linguistics) the *syntagmatic framework*. The syntagmatic framework is based on the assumption that design action, because of the immediacy of the phenomena it deals with, occurs predominantly at

the synthetic level of consideration. Thus to be operationally effective an architectural theory needs to accept a less deep level of abstraction than the purely syntactic (i.e. analytic) one for describing environmental structures. This level is the syntagmatic level. Its basic tool is the syntagmatic pattern in which *prototypes* which are highly structured can exist on multidisciplinary bases and can be used both for describing complex architectural structures and for designing them.

7. The level at which prototypes occur is the proper level at which a successful mediation between the theory of architecture and its practice is to be sought. Therefore, the bulk of the knowledge, method or technique sought from other disciplines should be directed towards elucidating this level of consideration and towards identifying, developing and enriching the empirical content of the prototypes.

8. 'Space' represents the most objective basis on which any prototype, or indeed any recognizable architectural structure, is founded. It is simply that whatever constitutes architectural space, constitutes architecture. It is crucial to formulate a proper conception of space if the nature of architectural reality is to be sufficiently understood. Hence the search for a methodological framework cannot be carried out in an *ad hoc* manner, but has to proceed simultaneously with the specific empirical object of the study, namely *architectural space*.

9. However, beyond its intuitive acceptance, space cannot be properly viewed outside the totality of architectural structures. And within this, it is no longer important whether architectural space or the built environment is *technically* describable in terms of a particular set of descriptors, but how comprehensive and well integrated this set is, in order to reflect the real identity of it.

10. As a methodological consequence, the need emerges to adopt a structural approach which not only recognizes the importance of the spatial and aspatial dimensions of architectural structures, but also organizes and presents the different images they take: their institutional image, their activity image and their environmental image. At deeper levels (the levels at which prototypes are conceived and internalized) the interdependence between these images can be profound and present a structural totality involving stable forms (morphology-synchrony), dynamic processes (transformation) and history (evolution-diachrony).

11. There are various contributions which the structuralist perspective (when properly qualified) can make to the formulation of a methodological framework. These are fundamentally conceptual. The most obvious interest afforded by structuralist thinking is not a precise method or technique by which any object-structure will be automatically discovered, but the insistence that the theoretical premises underlying any such method and the conditions under which it applies should be made as explicit as possible so

that they can be among the things held out for comparison and critical analysis.

12. An argument which is closely connected to this is that the structural analysis, of whatever object one is dealing with, is a product of a theory whose construction depends primarily on the nature of the object under consideration and on the derivation of the appropriate conceptual tools which permit the analysis of this object as a totality, that is as a system.

13. A structural approach, therefore, besides recognizing the specificity of architectural realities and the contexts in which they occur, must go beneath the level of their surface manifestation and habitual observation and establish how they manage to be continuously transformed while at the same time maintaining an internal order and a structural coherence which give them meaning and guarantee their functioning.

14. A structural approach, syntagmatically characterized and developed within an architectural context, accepts the involvement of meaning at the very bases of the structures it investigates, rather than seeing it as an *addendum* or *epiphenomenon*. In other words, the main value of adopting a syntagmatic strategy is that it embodies a semantic dimension dominated by social evaluation which is historically originated and which plays an internal role in characterizing a structure even at its very elementary formation.



15. The structural syntagmatic approach also recognizes the role of syntax in defining the rules and conditions which govern meaning, but views this syntax as a *syntagmatic syntax*. Unlike purely rationalized and descriptive syntaxes which are frequently single-valued and excessively analytic, syntagmatic syntax usually embodies more than one descriptive tool for describing a structure. It also accepts the contradictions and anomalies within and between the images created by the descriptive tools it adopts, and takes it as its prime task to identify them and enquire into their nature and their potential for transforming the structure itself.

16. Syntagmatic syntax also introduces the idea of an optimum level of abstraction for descriptive theories of architecture. This substitutes for the bipolar objectivity-subjectivity the concept of dynamic coexistence between a theory's abstract logical basis and the immediacy and reality of the objects of its investigation. The immediacy of architectural realities severely constrains the degree of abstraction of the descriptive theories concerned with them. It indicates that the most significant task before any such theory is not to attempt universal causal explanations, but to construct the appropriate operational links with the practice which produces these realities.

17. It is the study of prototypes which presents the appropriate operational link and provides for the conceptual unity between architectural descriptive theory and the practice of its design. The literature on design theory has been progressively

enriched with similar organizational concepts such as *pattern language*, *stereotype*, *solution type* and *design schema*. They all advance a similar argument to the one developed here to support the operational value of the prototype. What appears now to be urgent is to explore in depth not only the theoretical functioning of these notions in reorientating design theory, but most importantly to devise concrete research programmes which investigate their practical workings.

18. Under the syntagmatic framework, this thesis has suggested two interrelated areas of research. The first is that of *prototypic analysis of the built environment*; the second is the development of what has been termed *design-specific prototypes*. The first is mainly concerned with investigating the prototypic potential of the built environment. Besides providing a better understanding of the built environment itself, it can provide an essential basis either for developing the second area of research or, at least, a frame of reference under which it can be properly evaluated.

19. Research on design-specific prototypes is particularly concerned with proposing new prototypes, and analysing and testing their problem-solving capacity in response to a variety of emergent problem-situations. The most convenient origin for these prototypes is in those which already exist. However, the investigation of spatial form generally offers an equally rich source and this thesis has illustrated this with a worked example. The architectural validity of the example has not been fully demonstrated, but the

potential of its working has been explored.

20. The principle limitations of the thesis lie in the lack of detailed empirical support. Although some empirical content has been introduced at various points, this has not been sufficient to indicate fully the implications of the suggestions being made. However, despite an acute awareness of this, the complexity of the concepts involved necessitated concentration upon the theoretical discussion. The concepts themselves are contentious and have been subject to dispute. Hence little has been taken for granted. The major interest has been to view them critically and to treat them with the seriousness they deserve. The definitions given to them have always been evolved in an operational form. And this, indeed, has been the strategy throughout the thesis: to argue the case for the operational level.

## APPENDIX I

## DESCRIPTION AND DESCRIPTORS IN ARCHITECTURE\*

Foreword

This paper represents a combination of apparently different work carried out in the Department. The aim is both experimental, in terms of the effectiveness of this type of co-operative work, and essential in terms of the search for a common framework of description in architecture, within which architectural research may be organized. Fortunately - but not entirely by coincidence - the three individual approaches developed by the co-authors of this study<sup>1</sup> were found to be closely interconnected and constituting a conceptually self-sufficient system, as they have been corrected and revised by continuous feedbacks during the discussions. These revisions stimulated a reconsideration of each one's individual work.

The study is divided into the following five sections:

1. The dynamic nature of descriptive theories and their problem-origin.
2. Comprehensiveness and structural approach to descriptive theories.
3. The abstract syntax of microclimatic and network descriptors.

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\* *The contents of this appendix appeared originally in a collective paper written by the author of this thesis and his colleagues Dr T. Kotsiopoulos and Dr T. Maravelias. This paper has been published, under the same title, in Edinburgh Architecture Research (E.A.R.), Volume 3, 1976, pp.35-75, and is now reproduced here in its entirety. Several minor modifications, especially in terms of footnotes, have been rendered necessary following the adoption of the same general system of referencing authors and so on employed throughout the main body of the thesis.*

1. 'Network Structures and Architectural Design' (A. Awadalla); 'Barrier Structures and Participation Problems in Urban Universities' (T. Kotsiopoulos); 'Urban Microclimatic Structures' (T. Maravelias).

4. The importance of semantic considerations: towards a generative approach.
5. The syntagmatic nature of architectural descriptors and their problem-solving capacity.

1. On the dynamic nature of descriptive theories and their problem-origin

Descriptive theories are generally considered to be of static character. In this sense, terms like predictive, prescriptive, nomothetic, or normative are distinguished from the term descriptive. However, in this study 'description' is used in its broader sense of 'explanation'. Within this context description automatically implies both a 'behind' as well as a 'beyond' in terms of its historical evolution and its practical applications. Before discussing these basic characteristics of descriptive theories we shall distinguish between descriptive theory and descriptor.

Descriptors are the components of descriptive theories. In other words, they constitute the basis according to which a description may be implemented. A descriptive theory may consist of either one predominant descriptor which is being considered as the most important one, or a set of descriptors which supplement each other in a structural way within the framework of a descriptive theory. Comprehensiveness, therefore, emerges as one basic property of descriptive theories. However, comprehensiveness is not a property that a descriptive theory may technically acquire only by combining descriptors in isolation from both its historical origin and its structural context.

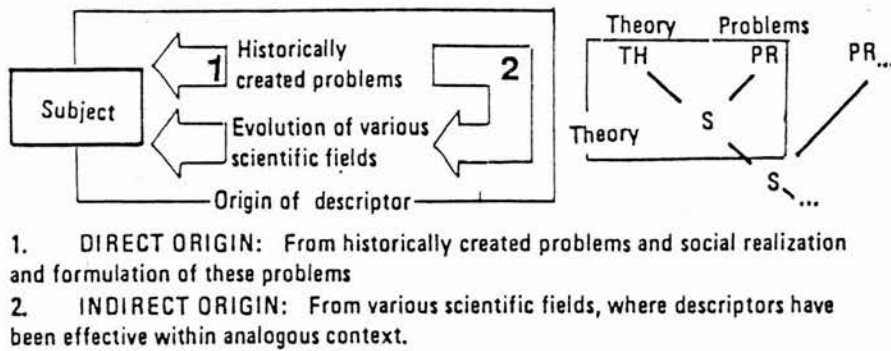
A basic assumption in this study is that sciences, as domains of particular knowledge, are historical products. This is especially true for the so-called 'social sciences' and the 'sciences of the artificial', in which not only their stock of knowledge, but also their very subject-matters are historically affected. The major explanation of this basic assumption is that these sciences describe human practices which are strongly influenced by ideologies. The additional reason that scientific paradigms in these sciences are equipped with 'behinds' and 'beyonds' is simply that it is extremely hard for the observer to consider himself excluded from the reality he investigates, though there are some serious objections to this particular thesis as far as comprehensive social phenomena, such as language, are concerned<sup>2</sup>.

In this study, it is not our intention to be involved in this epistemological question. What we are going to argue here is that descriptors in architectural descriptive theories are generated as products of historically created problems with which the practice of architecture is concerned. Thus, descriptors represent in a way the ideological struggle of the historical moment in which they appear. The history of description in architecture is quite short to prove this, due to the difficulties that the consideration of architecture as an art has imposed; a phenomenon common also to other fields such as language, music and painting in which the attempt of investigating an art in a scientific way is also a recent achievement.

Descriptors are derived historically according to the following general model:

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2. See Levi-Strauss' objections to Wiener's assumptions in Levi-Strauss (1963, p.56).



Present architectural thinking realizes that climate was always a basic generator of built forms. What led to the emphasis on micro-climatic descriptors - apart from some obvious reasons directly derived from industrialization, such as pollution, conservation of energy, etc - was the formalization of 'comfort' as a commodity.

The demand for comfort has always been central to architectural practice. What happened, however, after the Industrial Revolution and the technological advance of systems by which comfort may be achieved, is that comfort has been included in the course that Mandel (1974) describes as 'a system for constantly extending needs'. He writes (p. 25):

"The system must provoke continued artificial dissatisfaction in human beings because without that dissatisfaction the sales of new gadgets which are more and more divorced from genuine human needs cannot be increased."

It is very characteristic that P. O'Sullivan (1972) proposed the term 'lack of discomfort' in order to identify the subjectivity of the concept. This subjectivity is not only due to the inadequacies of psychological or other scientific tools to identify it, but is



also due to the recent function of comfort as something which one could buy and sell and which is consequently subject to the unstable character of market forces.

In addition to this direct reason for the emergence of micro-climatic descriptors in architecture, there are indirect ones such as the development of climatic considerations in other sciences, e.g. bioclimatology, psychoclimatology (connected with the general tendency towards a psychological approach to architecture) and so on<sup>3</sup>.

In the case of network descriptors, direct reasons are related to the possibilities of 'channelization' that contemporary technology has introduced and made possible. Physical elements like light, water, etc. have always been considered as having a social usefulness. However, it is the channelization of these which transformed them to manipulable and spatially specialized sources. The LASER is an example of this tendency signifying what might be called a second degree of channelization of light by which even non-visual communication signals may be transmitted.

Apart from this first level of understanding direct historical evolution of network descriptors, there is a second level at which not only the very nature of the channel is taken into account but also the complexity and accumulation of networks which are involved

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3. *The establishment of Microclimatology by Geiger in the mid-'20s, the development of Climatology, especially after World War II, beyond its purely descriptive bases, and the emphasis attached to problems like adaptation, acclimatization and so on in both man and machine constitute probably the most basic influences for the establishment and development of other scientific fields which have more directly influenced microclimatic descriptors in architecture. Such sciences include, for instance, bioclimatology - founded in 1956 and developed by Tromp in Holland - forecasting climatology - especially developed in the '60s - economic climatology - developed in the '60s, but more importantly by Maunder in 1970 when he brought together economic, social and atmospheric considerations in an attempt to put an economic value on climate and weather - and psychoclimatology - developed in the '60s, but particularly for architecture in the early '70s.*

in a given spatial form. Inevitably, to understand and solve this complexity, architectural descriptive theories have to exploit, in an indirect way, the evolution of mathematical theories of graphs and networks and sometimes, to try to generalize them in order to understand the built environment as a whole<sup>4</sup>.

If we consider simultaneously climatic modification and production of networks at their very elementary level, we might understand the duality of elementary architectural actions, that is, of producing barriers, in order to differentiate a physically homogeneous situation, and of producing channels, in order to bridge a physically heterogeneous one. This basic syntactic duality leads us to a structural approach of description in architecture, but closely connected with its historically created meaning and social evaluation.

## 2. Comprehensiveness and structural approach to descriptive theories of the built environment

Environment has been considered in Ecology as the aggregate of external conditions that influence the life of an individual or of a population of organisms. The term 'built environment' implies the particular impact of man on modifying the natural environment of a specific place and producing what is generally known as 'human settlement'. In this sense, then, built environment might be defined either as a totality of natural and artificial components or as a set of elementary actions of modifications of natural space transformed

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4. *Graph theory was founded with L. Euler's formulation and solution of the first graph-theoretic problem in 1736. Incidentally, this had been conceived as a built environmental problem. It was the famous Königsberg Bridge Problem. More than a century later J.C. Maxwell and G.R. Kirchoff discovered some basic principles of network analysis in the course of their studies on electrical circuits. However, books on the subject started to appear only after World War I and wider interest was much awakened only after World War II. Now, of course, it is a well established branch of mathematics of wider popularity and applications in numerous fields of inquiry.*

into logically higher forms.

This distinction introduces two quite different ways of investigating the characteristic of wholeness which has been attributed to the built environment by the current descriptive theories in architecture. The first way reflects a present trend in architectural theories borrowed from the general tendency in modern sciences and well developed by Bartalanffy (1968); that is, to approach the notion of wholeness and consequently comprehensiveness from a 'systemic' view. Here comprehensiveness is inevitably accompanied by continuously increasing complexity. In such a way, it places limits to the degree of wholeness which might be achieved.

The second way reflects the present structuralistic thinking which is also an approach to problems of wholes. However, it does so, trying at the same time to reduce complexity, by using the most elementary operations together with transformational rules which lead to higher structures, in order to attain comprehensiveness with simplicity.

According to Piaget (1971, p.19) wholeness can be attained genetically by 'reflective abstraction'. This means that while in the systemic mode of thought a property can be derived by being drawn out of things, by reflective abstraction properties are derived from the way in which we act on things. It is quite natural to expect descriptive theories in architecture - dealing particularly, as other sciences of the artificial do, with the results of human actions - to be more amenable to reflective abstraction than to the systemic way of thinking. The deep character of reflective abstraction is that description becomes anthropocentric and

consequently historically created. It is this point which has made many authors, including Piaget, conceive reflective abstraction in close connection with the Marxian concept of 'praxis'<sup>5</sup>.

So structuralism and historical explanation become reciprocally related. History may be explained structurally - as in a way Marx did - and structuralism together with the descriptive theories based on it, may also be explained historically - as Piaget (1973, Introduction) has clearly pointed out.

The practical significance of this very general remark is that it introduces the only way in which elementary structures may be formed. Furthermore, it shows the way in which the question of whether or not the investigator should try to find an abstract context for these structures may be answered; implying that this abstraction is simply without any importance if it is not to solve the problems that have produced it.

Piaget's 'Genetic Structuralism' is a general method of enquiry based on the concept of totality (wholeness), self-regulation and transformation, common not only to linguistics and anthropology where it has primarily been developed, but also to mathematics, physics, biology, philosophy, the social sciences and so on.

'Semiological Structuralism' is another type of structuralism developed especially in the Saussurian linguistics and in the anthropology of Levi-Strauss. It has developed out of the assumption that theories of structural linguistics are directly or indirectly

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5. *"Fortunately too, living scholarship leads to the rediscovery of the method by those who might not otherwise regard themselves as 'Marxists'. Perhaps the most outstanding example in recent times is Piaget....Marx might be surprised to find himself described as an 'operational structuralist'." (Harvey, 1973, pp.287-8).*

applicable to all aspects of human culture insofar as all of these may be interpreted, like language, as systems of signs (Robey, 1973). This way of thinking, in turn, presupposes the adoption of semiotic dimensions in these systems of human culture. This type of structuralism, though adopts a quite distinct body of thought, accepts all the principles of Piaget's genetic structuralism. Piaget's later work, however, has also been expanded to this type of structuralism which could investigate interdisciplinary problems of the broadest kind (Piaget, 1973).

At present there is a tendency to formulate descriptive theories in architecture using semiological structuralism as a methodological background<sup>6</sup>. This is based on the notion that architecture is predominantly a system of signs which may be compared with purely semiological systems such as language, painting, music and so on.

We generally agree with this approach, not because architecture may be only semiologically explainable but more importantly because of the following two reasons which belong to the methodological aspect. Firstly, the notion of meaning which is implied by semiological structuralism is crucial to architectural description, particularly in the generalized form of meaning, that is, 'social evaluation'.

Secondly, there is a level at which the methodological advantages of both the genetic (general and abstract) and the semiological (socially meaningful) approaches may be resolved. We shall

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6. See, for example, Jencks and Baird (1969).

call this level 'syntagmatic'. One of the main aims of this paper is to show how this level may be generated, particularly in architecture. Before doing this we shall refer to some basic concepts starting from what might be called a purely syntactic approach to our descriptors.

### 3. The abstract syntax of microclimatic and network descriptors

Syntax may be considered as the level at which the generation of structures which may be apparently observed is investigated achronically according to the chain from the elementary to the complex. In linguistics - and other semiological sciences - the involvement of meaning has been mapped on syntax by producing what has been called the chain from deep to surface structures. There has been a long discussion between linguists on how semantics are involved in the 'deepness chain' and we shall refer to the importance of this discussion to architecture in the next section.

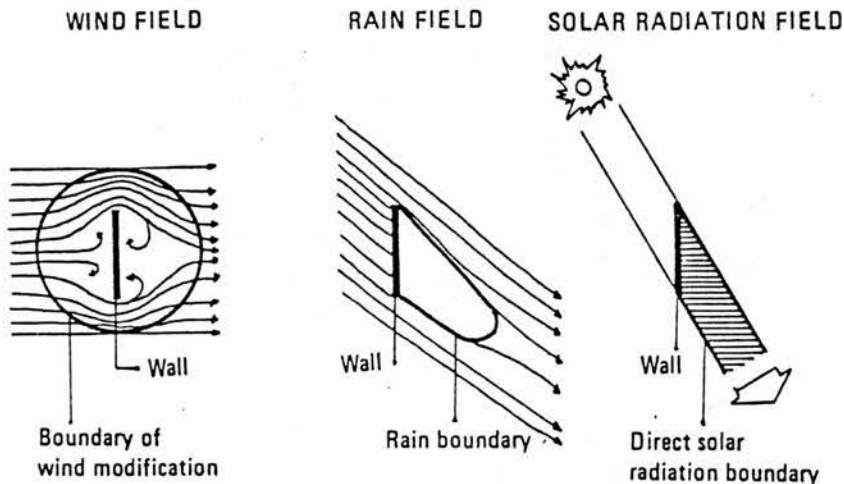
Apparently, in architecture, both the syntactically pure complexity chain and the ambiguous deepness one may be considered simultaneously. Here, complexity chain means that we assume that the complex structures we observe have been generated by successive transformations of elementary structures. Hillier and Leaman, being interested in the evolution of deep structures, are trying to introduce a syntactic terminology appropriate to architecture. They adopt the view that elementary structures in architecture are barrier-structures whose evolution towards higher structural degrees may be described by functional variables - such as contiguity, differentiation, boundaries and permeability - and operational rules aiming at



transforming simpler structures into higher ones (Hillier and Leaman, 1974b). The key to their analysis lies in the concept of the internal transformability of an object. This distinguishes the structural approach from the systemic one as far as intelligibility is concerned (mostly related to our term of 'comprehensiveness'). (Hillier and Leaman, 1974a,p.6).

The elementary operation in modifying climate - where it is considered achronically and on a statistical basis - may be described as an elementary barrierization of physical climate.

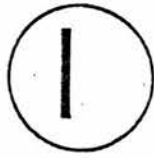
Consider a building element; for instance, a wall. By creating a wall we modify the various climatic fields such as wind, temperature, radiation, humidity, precipitation, etc. The result is that different boundaries are produced, attributing to the specific operation of barrierization a multifunctional character. These boundaries indicate the particular differentiations which occur in each climatic field:



The physical properties that, in the classical theory of physics, interconnect these fields imply some fundamental characteristics of elementary microclimatic deep structure, analogous, for instance, to



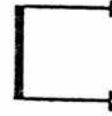
the rule of linearity in language.



Wind modification  
boundary: Always  
on both sides of  
the barrier



Rain boundary:  
Always on the one  
side of the barrier

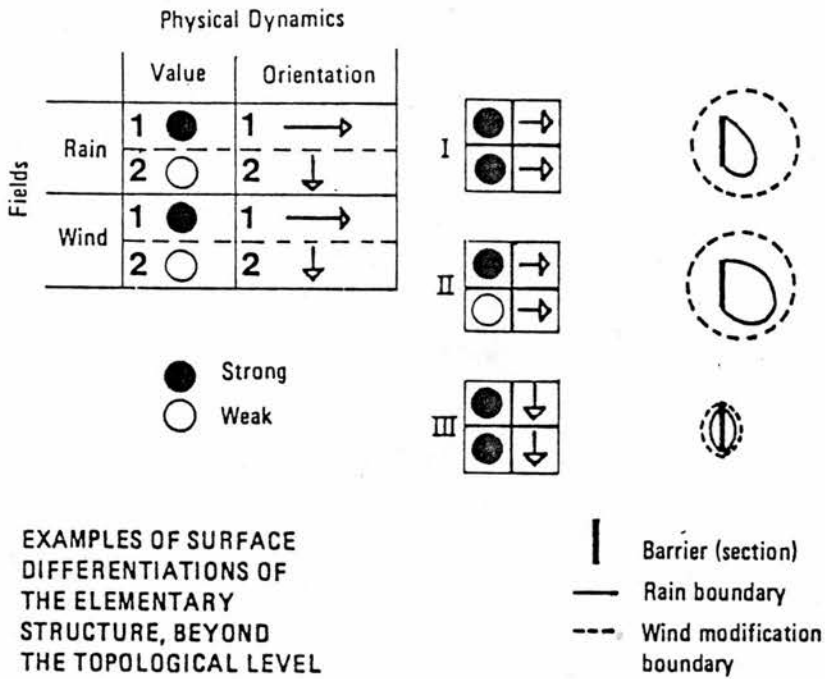


Direct solar radiation  
boundary: Always on  
the one side of the  
barrier

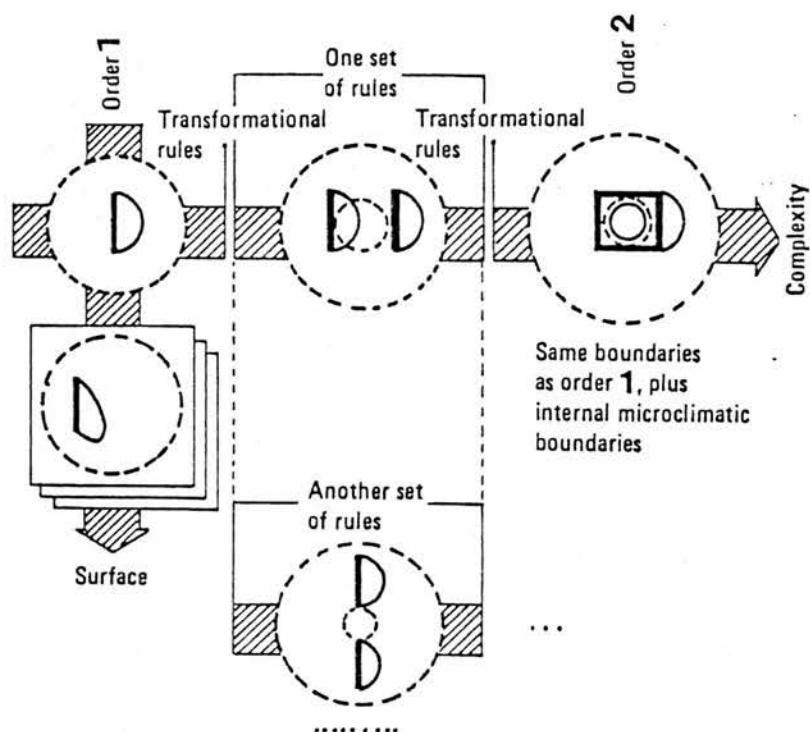
TOPOLOGICAL CHARACTERISTICS OF ELEMENTARY CLIMATIC  
BARRIER STRUCTURES.

Obviously, these are images which have been necessarily derived from the involvement of a semantic dimension rather than from a pure physical actuality. Of course, in a strictly physical sense, rain and solar radiation boundaries are topologically identical to the wind boundary. However, we have considered them in the way shown in the diagram above - speaking about 'modification' in terms of wind but, at the same time, about 'presence-absence' in terms of rain and direct solar radiation - because of the fact that in architectural thinking even abstract elementary structures can not be isolated from a certain semantic context. This is a central point for this study to which we shall repeatedly refer at different levels leading to the notion of syntagmatic approach.

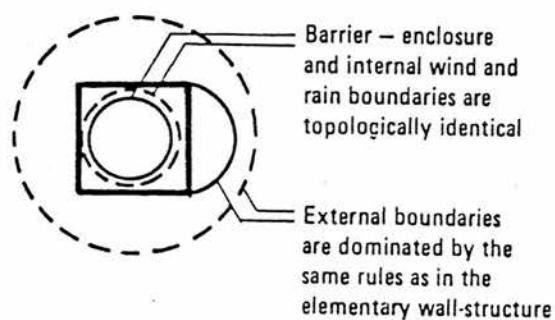
The path from deep structures to the surface ones, in terms of the syntactically elementary structure, may be understood by introducing the physical dynamics of the climatic fields, such as orientation, value, etc.



Built environment structures, of the elementary type discussed previously, are very rarely realized, since they are mainly understood after they have been transformed into structures of higher complexity, such as 'enclosures'. The application of transformational rules is characterized by an evolutionary chain in which a structure at a given complexity level becomes the generator for the one at the next level. Consider once more the elementary structure expressed in terms of wind and rain climatic fields:



Again the physical properties that interconnect the micro-climatic fields imply fundamental characteristics of higher complexity deep structure, such as:



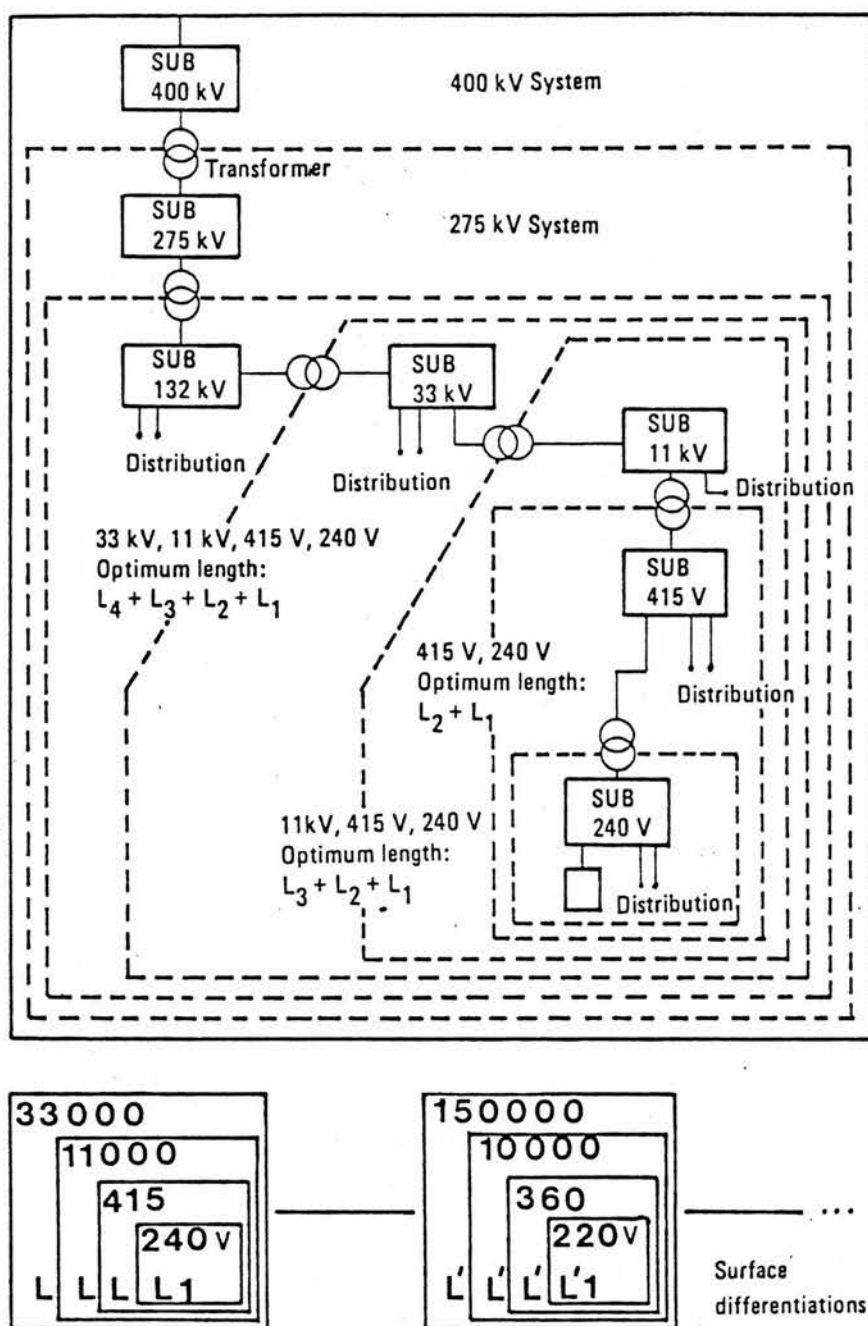
Channelization of space may be considered as the elementary operation of eliminating physically or artificially existing barriers. Channels constitute elementary deep structures which at a surface level may represent a variety of networks, such as electricity, water, drainage, circulation, etc. The very nature of a channel implies, even at the most elementary level, a source, a destination, and a span between them which signifies that flow is a specific aim of elementary operations in channels, as opposed to the elementary microclimatic barrierization where the aim is to interrupt or disturb a physically existing flow.

Networks as we understand them in the built forms are already equipped with a semantic interpretation, in the same sense as microclimatic descriptors already include the semantics of the physical fields. In order to identify what deep structure - and consequently deepness chain - of a network could mean, we have to refer to the 'Erlanger Program' by F. Klein, mentioned by Piaget (1971, pp.21-22), in order to show the 'fruitfulness' of structuralism. So the deep level at which we abstractly understand networks is the topological one and is expressed in the language of graph theory. According to this, graphs are just trees, semi-lattices or lattices where only connectedness is of primary importance. We have to introduce quantities in order to reach another level of complexity at which graphs begin to be transformed into networks (March and Steadman, 1971, p.268). In the next higher level, we may conceive of a network as a cybernetic mechanism. At this level, the nature of the network is identified by concepts like inputs, outputs, the particular identify of control mechanisms which it includes and so on.

The introduction of physical properties of flow leads to the last 'deep' level in which a network is identified as energy, commodities, human circulation, etc. This level is quite different from what we mean here as a surface structure of a network.

If we consider networks as we understand them at this 'deep' level in the built environment, we can identify chains of complexity which depend on the particular properties that may be identified at any of the previously mentioned deep levels. The important point here is that these complexity chains consist of concrete structural orders and are transformed according to a set of transformational rules.

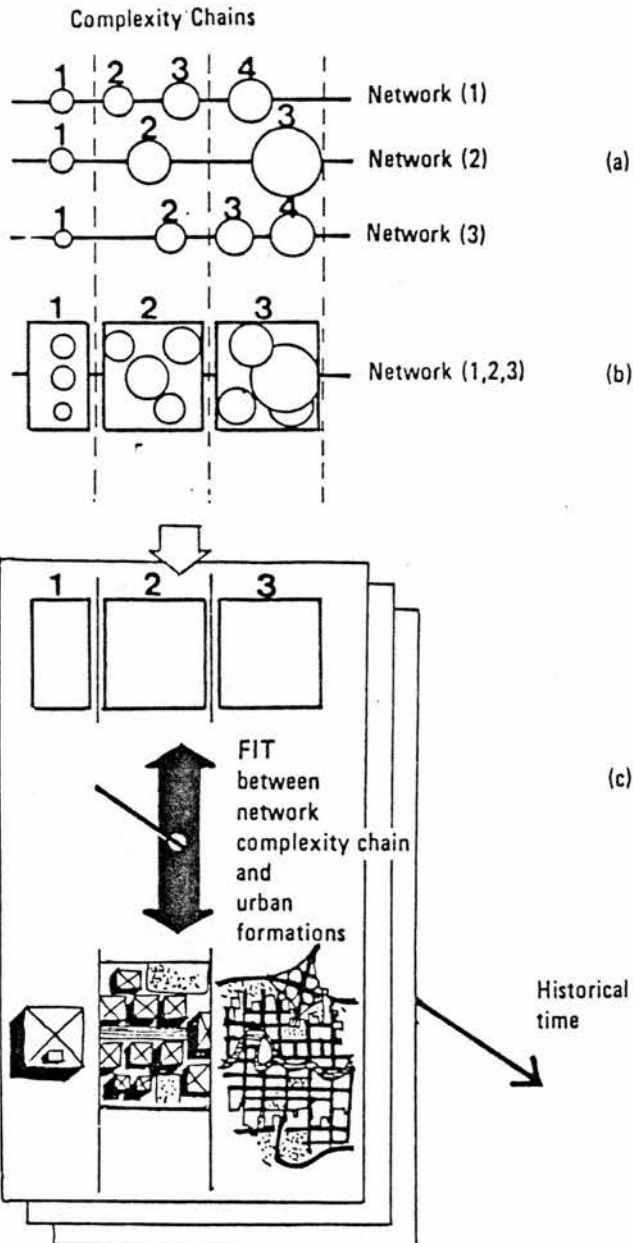
Consider, for example, electricity networks:



After *Electrics 72/73*, the Electricity Council Handbook of Electrical Services in Buildings (1973, pp.30-31).

To find what might be called a 'general complexity chain of

networks' in which all types of networks are to be combined, we note that we have to ignore the physical properties of networks as such, and to take into account the most deep levels of them. Such a general chain is represented by the following diagrams:



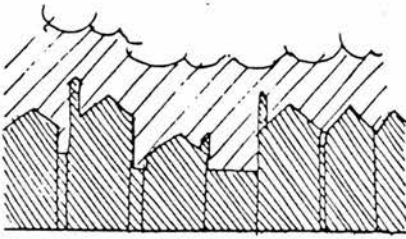
The reason for producing such a hypothetical chain (b) is because we need to equip this chain with a higher semantic level in order to achieve, in a holistic way, the correspondence to the structural complexity levels according to which the artificial environment is



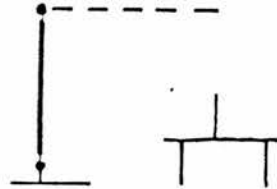
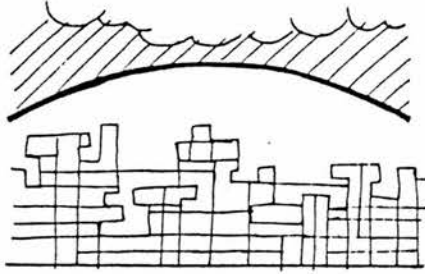
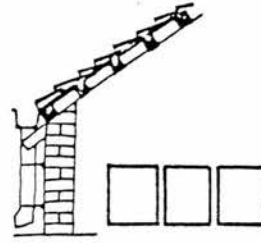
formed. However, what happens in reality is that technology tries to modify the physical properties of networks in order to make this correspondence achievable, but at the same time, built forms have to be structurally developed so as to be compatible with the existing technological level at a given time.

This general pattern, which is quite similar to the case of microclimatic descriptors, shows both the limitations of the purely syntactic approach and the weak connection between isolated syntactic approaches and problem solving processes and leads to what we shall call later the 'syntagmatic' approach.

Elementary architectural operations are initially concerned with barrierization in order to modify climate. Obviously, the history of architecture does not signify a very strong change in the way that this elementary barrierization is worked out, but signifies a remarkable change in the way this operation is socially evaluated. As opposed to this, the historical evolution of channelization does not show only a differentiation of the social evaluation of networks, but also important changes in the physical properties, the identities, and the complexity of them. We may refer to proposals like those of Buckminster Fuller, in which climatic fields (wind, temperature, etc) would be altered, in order to imagine what such a change of physical fields by technology could mean in terms of the elementary barrierization:

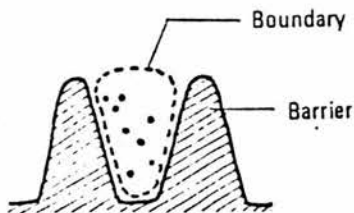


Usual manipulation of microclimatic barriers

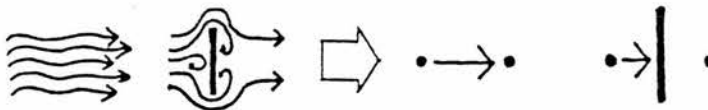


Manipulation of microclimatic barriers after an alteration of physical fields by technology

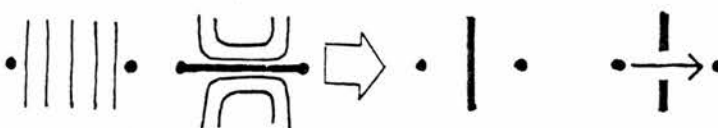
It is quite difficult to show how elementary architectural actions may constitute a subject of valuable description, apart from their semantic context. However, it is possible to show this in a very abstract way, in which the dialectics of the concepts of 'barrier' and 'boundary' have to be given deep consideration.



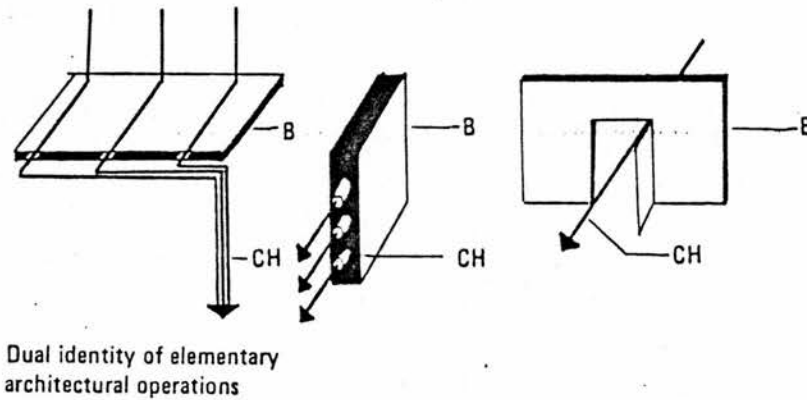
Elementary barrierization



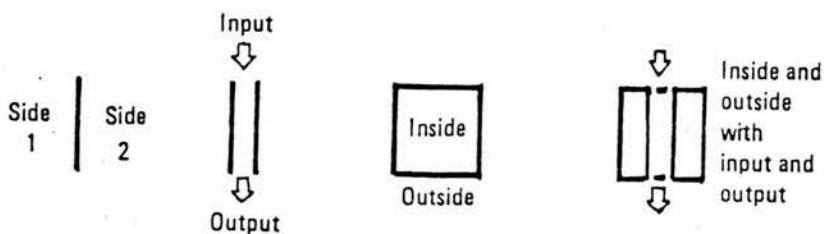
Elementary channelization



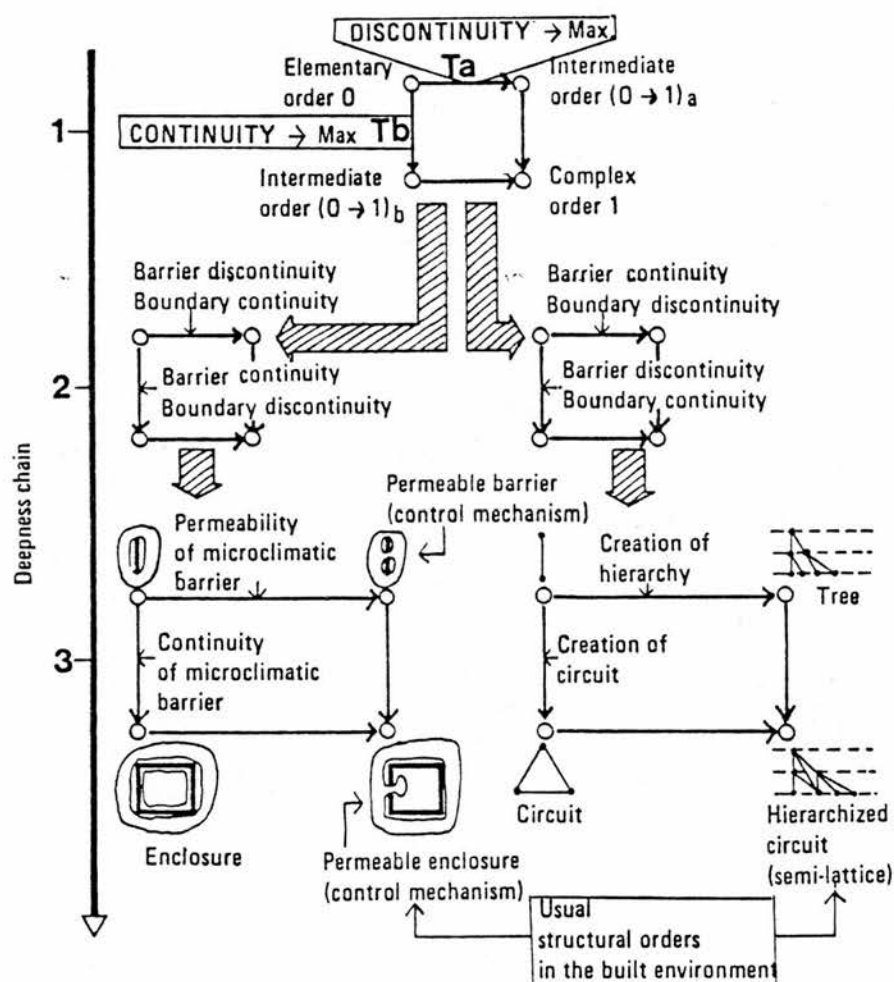
The simplest abstract architectural gesture is probably barrierization, but in simplest real architectural operations barriers are structured together with channel-boundaries. This very basic characteristic is shown in the following examples:



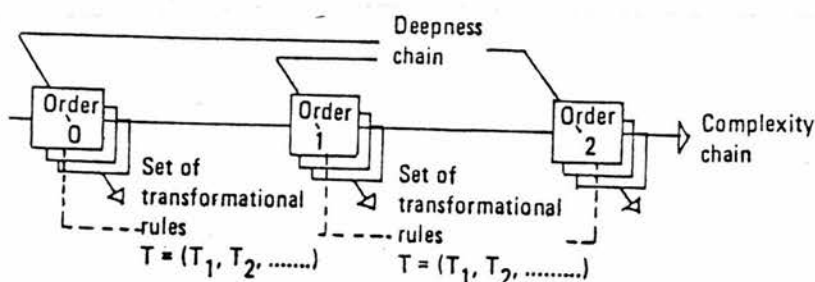
A theoretical mind, well convinced about the descriptive value of syntax, may proceed towards a common consideration of both micro-climatic and network descriptors in terms of their structural characteristics. A first way of approaching this is by constituting a chain in which even channels might be reached by transforming the elementary barrier deep structure:



However, this common consideration is better achieved if the transformational model (the model which structures the rules of transformation and the variables that characterize each structure) which dominates the syntactic chains, created by the two descriptors, satisfies a common logical basis represented in terms of a commutative square:



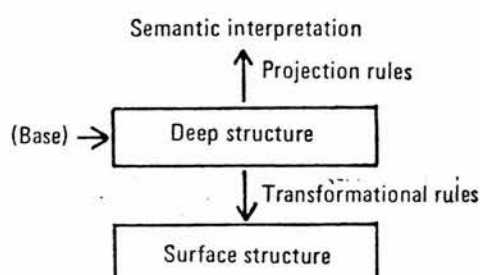
Or more generally:



Such a highly theoretical consideration would be in danger of explaining intelligible and socially evaluated things in a complicated way, if it did not take into account what we will later call the 'syntagmatic' identity of the structures. Even in the previous diagrams, we can observe the involvement of syntagmatic considerations when, for example, 'continuity' and 'discontinuity' first refer to barriers and boundaries and secondly take forms like 'boundary discontinuity through hierarchy' (in order to reach the tree-network, useful for flow regulation) or 'boundary continuity through permeability' (in order to reach the permeable microclimatic barrier, useful for microclimatic regulation). The syntagmatic consideration is discussed in detail in the course of the following sections.

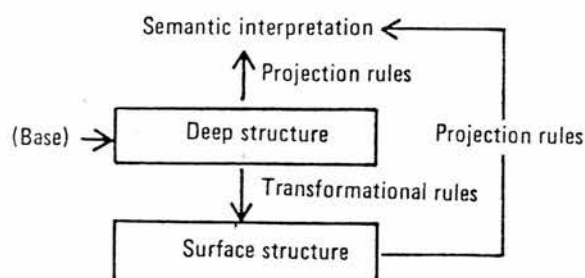
#### 4. The importance of semantic considerations; towards a generative approach

According to the initial model by Chomsky (1965) semantics in linguistics are derived from the syntactic deep structure as follows:



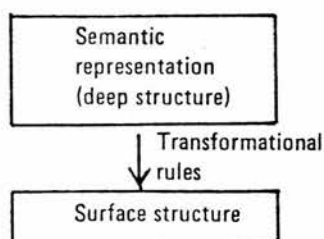
After Leech (1974, p.328)

By 1970, Chomsky revised this model to the following one:



After Leech (1974, p.329)

Both Chomskyan versions constitute what has been called the 'interpretive approach' to semantics, and thus have been distinguished from a recent approach called the 'generative' one (Leech, 1974, p.324ff). According to the generative approach semantic interpretation is no longer derived from the purely syntactic deep structure, but the structure is so deep (this is what is called the 'base' in the Chomskyan versions) as to be identical with semantic interpretation. In this manner projection rules disappear and the model becomes simpler as follows<sup>7</sup>:



After Leech (1974, p.330)

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7. We are not dealing here with phonology.

Traditionally, semantics deals predominantly with the concept of 'meaning'. C.K. Ogden and I.A. Richard (1923) wrote on what they called *The Meaning of Meaning*. The important point made by Ogden and Richard, later by Bloomfield (1933) in *Language* and quite recently by Leech (1974) in *Semantics* is that meaning may best be studied as a purely linguistic phenomenon in its own right. Leech, however, proposes instead of meaning the concept of 'communicative value'. Value in semantics explains the way in which the meaning of a semantic unit is developing from the total set of semantic units. In this way, value introduces the notion of 'system of evaluation' which in the case of language is, of course, one aspect of the system of communication. This means that, apart from the system of verbal communication - with which language is concerned - we can refer to a broader semiotic framework which extends the dimension of communicative value beyond language.

Piaget (1971, pp.20-24) points out that in all spheres of human behaviour there are systems of meanings the essential parts of which are studied by linguistics, but he stresses the fact that, although language has played a basic role in the transmission of values and rules of every kind, it is not the only system of signs or symbols by which these values and rules have been originated. For instance, the appearance of representation in individual development is not due to language alone, but to a much wider semiotic function. He proceeds by suggesting that language constitutes a system of meaning in the power of one and it is accompanied in collective life by systems to the power of two, such as myths, which are simultaneously symbols and semantic characters.



It is the notion of 'convention' - mentioned also by Piaget (1971, p.53) - attached to signs and meaning that incorporates the social and historical character of meaning and that allows us to introduce a broader concept which is concerned with the social evaluation of signs. Thus to the chain of linguistic meaning → linguistic value → communicative value → broader value, we may add social value, directly dealing with historical evaluation. So, the simple concept of meaning, appropriate for linguistics, is replaced by the concept of 'historically created social evaluation' which allows us, even starting from a purely semiological base, to enlarge its context in order to include the broader social character of systems like architecture. Morris (1946) uses the analogous concept of 'pragmatic meaning' in order to transfer the linguistic meaning - which he refers to as 'syntactic meaning' - to the sphere of examining the sign in relation to operations and behaviours.

The historical evolution of the social evaluation of products - which at first sight might be only evaluated semiologically- means that we accept that each particular historical period is characterized by a particular balance of systems of evaluation. Communication - and consequently communicative value - is, of course, only one of them.

Systems like painting, music and language have always been dominated by communicative values while architecture shows a different history. For instance, it is quite easy to understand that communicative value has dominated the production of artefacts as far as official or religious architecture is concerned, from the Pyramids to the contemporary phenomenon of returning, at a morphological level, to the deep structure. This 'return' is supposed to facilitate

production, and produce another kind of communicative value by the very acknowledgement of this return. Banham (1960, p.321) emphasizes this point when he speaks about *Functionalism*.

"Under these circumstances it was better to advocate or defend the new architecture on logical and economic grounds than on grounds of aesthetics or symbolisms that might stir nothing but hostility. This may have been good tactics - the point remains arguable - but it was certainly misrepresentation. Emotion had played a much larger part than logic in the creation of the style; inexpensive buildings had been clothed in it, but it was no more an inherently economical style than any other. The true aim of the style had clearly been, to quote Gropius's words about the Bauhaus and its relation to the world of the Machine Age '... to invent and create forms symbolizing that world' and it is in respect of such symbolic forms that its historical justification must lie."

What we have to add to this is that the deep structure of this contemporary symbolism signifies - not in terms of each architect's emotional reaction, but in terms of social evaluation - the development of an economic basis of symbolism and what is more important, the beginning of 'internalization' of this development.

Such an 'internalization' has already dominated other fields of description of human practice and one of the most important deep characteristics of contemporary architectural thinking is that it does not only assume the significance of an economic basis in the limited symbolic context of architecture, but also acknowledges the necessity of the interdisciplinary character of it. Harvey is a good example of this. He points out that:

"In asserting the primacy of the economic basis Marx was proposing two things. First, he is suggesting that the relationships between structures are themselves structured in some way within the totality. In a conflict between the evolution of the economic basis of society and elements in the super-structure, it is the latter that has to give way, adapt, or be eliminated. Some structures are therefore regarded as more basic than others within a totality. Structures can therefore be ranked in order of significance. Marx obviously decided that the conditions concerning the production and

reproduction of material life were fundamental - he certainly argued more strenuously for this view. And this led him to his second main point. When we attempt to view society as a totality, then ultimately everything has to be related to the structures in the economic basis of society." (Harvey, 1973, p.292).

One should expect that economic bases have been constituting the fundamental system of social evaluation of architecture because of the hardware operations required to produce architectural artefacts and the difficulty of reproducing them. This has been happening also in other systems - consider, for example, stone writing or sculpture - but the additional property of architecture is that it has mainly to do with land use and economic resources. We shall try to make a rough comparison of four systems of human practice: architecture, language, painting and music:

| COMPLEXITY<br>CHAIN ↓                           | SYSTEMS                            |  |                      |  |   |
|---|------------------------------------|--|----------------------|--|---|
|   | LANGUAGE                           | MUSIC  | *                    | PAINTING   | ARCHITECTURE  |
| SUPER<br>SURFACE<br>STRUCTURE                   | Poem                               | Piece<br>of music                                    | Surface<br>structure | Painting   | Building  |
| SURFACE<br>STRUCTURE                            | Prose,<br>Sentence                 | Elementary<br>exercises<br>on musical<br>composition | Deep<br>structure    | (Painting<br>as a<br>picture)                        | (Building<br>compartmentalization+<br>+ activities'<br>organisation etc.) |
| DEEP<br>STRUCTURE                               | (NP - Aux - VP)                    | (Bar<br>structure)                                   | Underlying strings   | Basic<br>organization<br>of painting                 | Basic organisation<br>of building<br>(enclosure +<br>+ access etc.)       |
| UNDERLYING<br>STRINGS<br>(RULES OF<br>THE BASE) | Linearity,<br>Contiguity,<br>etc.  | Tonality,<br>harmony,<br>rhythm,<br>etc.             |                      | Rules of<br>combining<br>materials +<br>balance etc. | Building<br>physics,<br>etc. +<br>+ balance, etc.                         |
| CHOSEN<br>ELEMENTS                              | a, b, c, ....<br>phonemes,<br>etc. | Tones,<br>etc.                                       | Chosen<br>elements   | Colours,<br>materials,<br>etc.                       | Materials,<br>etc.  |
| * After L. Bernstein (1976)                     |                                    |  |                      |  |   |

Social evaluation appears at a final level which has been already called 'super-surface structure' and which, particularly in painting, music, and language, has been considered as the aesthetic one. Specifically in language, what has been accepted by Chomsky as surface structure constitutes a level which does not exist in the other systems as a self-sufficiently evaluated level and it is the result of the highly communicative power of language.

Nevertheless, in architecture it is not only the aesthetic evaluation which constitutes the system of social evaluation, as opposed to music and painting in which, because of the ease of reproduction, aesthetic evaluation has historically become predominant. The bipolar form-substance, for instance, may be used as a basis which clarifies a comparison among these systems. Although these systems are comparable in terms of form, they are quite different as far as the substance of their final product is concerned. Substance in painting is completely preserved from the chosen elements to the super-surface structure. Language and music belong to another category in which there is always the opportunity of conceiving both systems either in a written or in an oral substance. Architecture belongs to another category in which the super-surface structure is reached through a mapping which is quite different from the substance of the real product. The important difference between these last two categories is concerned with the process of producing the super-surface structure and not with the process of resolving and understanding it.

This deals directly with the economic bases of social evaluation in architecture, which allows us to interpret the nature of the production of architectural 'syntagms' and what might be called

pragmatic meaning in architecture. Indeed, the four systems may be compared as shown in the following table<sup>8</sup>.

| PROPERTIES OF<br>SUPER SURFACE<br>STRUCTURE (SSS)<br>SYSTEMS | UNIQUENESS/<br>PERFORMANCE                           | VALUE<br>AS A<br>COMMODITY                   | OTHER<br>ECONOMIC<br>UNITS   | CATEGORIES   |
|--|--|--|--|--|
|  | A  | B  | C  | A·B·C  |
| LANGUAGE<br>1  | Dynamic &<br>reproducible<br>character<br>of the SSS | Minimized<br>economic<br>value of<br>the SSS | Minimized<br>cost of<br>producing<br>the SSS                       | DYNAMIC,<br>EVALUATED<br>COMMUNI-<br>CATIVELY,<br>REPRODU-<br>CABLE<br>1.2   |
| MUSIC<br>2   |  |  |  |  |
| PAINTING<br>3  | Static &<br>unique<br>character<br>of the SSS        | Maximized<br>economic<br>value of<br>the SSS | Low cost of<br>reproducing<br>the SSS                              | STATIC,<br>EVALUATED<br>COMMUNI-<br>CATIVELY,<br>REPRODU-<br>CABLE<br>(ERSATZ) 3                                     |
| ARCHITECTURE<br>4  |  |  | Maximized<br>cost or<br>producing<br>and<br>reproducing<br>the SSS | STATIC,<br>EVALUATED<br>IN A<br>COMPOSITE<br>SYSTEM,<br>REPRODU-<br>CABLE BY<br>CHANGING<br>SUBSTANCE<br>(MAPPING) 4 |

8. *Industrial design is a particular category in terms of production of the artificial super-surface structure in which aesthetic value has been greatly replaced by a set of operational advantages concerned with the prototype. However, in industrial design, especially because prototypes are designed in order to be reproduced, the ability to be a commodity gets an aesthetic value, reversing the traditional scheme. This new kind of aesthetically evaluated functionalism may be very easily acknowledged in contemporary forms of architectural design (P.S.S.H.A.K., infrastructural design for flexibility, etc).*

5. The syntagmatic nature of architectural descriptors and their problem-solving capacity

The introduction of the notion of syntagm is an inevitable consequence of the complexity of social evaluation in architecture and the strong historical character of this evaluation. Such a notion presupposes that we are closer to the generative approach in terms of the deepness chain and not to the interpretive one, the last possibly being convenient for purely communicative and reproducible systems such as language and music<sup>9</sup>.

According to Saussure (1974, p.123) syntagm in linguistics is a "combination of consecutive units supported by linearity". 'Syntagmatic' relations are considered in semiology as being opposed to 'paradigmatic' ones<sup>10</sup>. This philosophical distinction which might also be derived from that between 'structure' and 'taxonomy' would not reflect the real importance of the syntagmatic approach if the concept of syntagm does not include the logical understanding of a sentence which is the simultaneous reference in both syntactic and semantic levels. Thus, the syntagmatic approach to a structure includes the social evaluation of even the elementary deep structures.

The function of prototypes in architectural practice has characterized its whole history both at a 'language' level by producing different styles and at a 'speech' level by influencing

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9. *These notions ('interpretive' and 'generative' approach) have been discussed in the earlier part of Section 4.*

10. *According to Lyons (1973, p.12), "The syntagmatic relation which an element contracts are those which derive from its combination with preceding and following elements of the same level.... The paradigmatic relations contracted by an element are those which hold between the actually occurring element and other elements of the same level which might have occurred in its place."*



the individual way in which architectural surface structures have always been produced. What we propose here is that prototypes do not constitute anything but syntagms, in which the semantic component cannot be isolated from the syntactic one. Particularly in architecture, prototypes have played the role of 'already structured' elementary units which have always carried a special meaning. Apart from this obvious way in which everyday-architecture has been practiced, even revolutionary moments in architectural history could not be explained syntactically as one would expect at first sight. What happened, for example, in recent architectural history is that only the communicative meaning has been minimized while social evaluation - that is, pragmatic meaning - has been enlarged and has been mainly dominated by economic values.

Syntagms have been dominating not only the historical evolution of architectural practice, but descriptive theories in architecture as well. In recent descriptive theories, for instance, it is possible to see emphases and predominancies of particular systems of evaluation which define the specific character of them. The historical evolution of descriptors in architecture is closely connected with the historical evolution of these systems of evaluation.

Consider, for instance, three theories in architecture concerned with the description of the built environment and its 'beyonds'. In these theories - by people who have been basically trained in quite different disciplines - we shall see how the general principles reflect the emphases on specific systems of social evaluation in the way we called syntagmatic, and also how such syntagmatic approaches differentiate the syntactic chains which might be derived from them.



Lynch (1960), in the preface to *The Image of the City*, is concerned with "the look of cities, and whether this look is of any importance, and whether it can be changed". His work, which is predominantly experimental, stresses the syntactic aspects of built form by analysing its 'environmental image' into three components, 'identity', 'structure' and 'meaning'. By definition, the whole of this approach is based on the communicative value of built form. He points out that:

"So various are the individual meanings of a city, even while its form may be easily communicable, that it appears possible to separate meaning from form, at least in the early stages of analysis. This study will therefore concentrate on the identity and structure of city images." (Lynch, p.9).

Lynch could not avoid the syntagmatic dimension in his work - even working in a purely systemic way - since he had himself pointed out that symbolic, aesthetic and other values beyond the communicative one are also of equal, if not more, importance. Furthermore, what is striking is that city images, even in terms of communicative value, are grouped according to social classes, age, sex, education and profession.

Lynch has tried to investigate syntax chains evaluated socially in terms of human perception, cognition and communication. The components of his elementary structure<sup>11</sup> inevitably include this particular kind of semantic interpretation, and consequently the whole structural chain does the same, belonging by definition to the syntagmatic approach.

We have to look at his chapter concerned with 'metropolitan form' in order to imagine how this chain may be descriptively identified and to show how flexible is the syntactic chain and social

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11. 'Paths', 'edges', 'districts', 'nodes' and 'landmarks'.

evaluation according to the system of meaning we use.

Apart from his first technique - which is less structural and more systemic - to identify the way in which higher order structures (such as metropolitan ones) may be formulated, it is quite interesting how structurally valuable is the second one in which the elementary structures already contain the powerful attributes (always within the communicative context) that allow them to produce higher order structures. He points out (p.113) that:

"The second technique is the use of one or two very large dominant elements, to which many smaller things may be related: the siting of settlement along a sea-coast, for example; or the design of a linear town depending on a basic communication spine..."

The structural chain that may be produced in such a way is syntactically different compared, for instance, with what we might understand as a hypothetical abstract topological syntax of a city, as might be suggested by the first technique.

Alexander represents the kind of investigator who moved from the predominantly syntactic aspects of design to the syntagmatic ones. In his first book *Notes on the Synthesis of Form* (1964) he tried to establish a general mathematical syntax according to which elementary structures were to be equipped with some semantic interpretation<sup>12</sup>.

In the preface to a recent edition (Alexander, 1974) of the above book, he states:

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12. Alexander uses the word 'needs' which later (in *The Atoms of Environmental Structure* (Alexander and Poyner, 1967) he transforms into the word 'tendencies'.

"At the time I wrote this book, I was very much concerned with the formal definition of "independence", and the idea of using a mathematical method to discover systems of forces and diagrams which are independent. *But once the book was written, I discovered that it is quite unnecessary to use such a complicated and formal way of getting at the independent diagrams.*"  
(His emphasis)

The recent work of Alexander (after 1967) reflects this remark, since it has been directed towards creating what he has called 'pattern language'.

So Alexander accepted the already structured prototypes (purely syntagmatic) and also the differentiation of their syntactic characteristics caused by political, social - in a word cultural - demands. By attempting to establish an institution like the *Center for Environmental Structure*<sup>13</sup>, he simply realized the social significance and changing character of architectural prototypes and tried to find a technique to record them and to produce his flexible 'environmental pattern language'.

In Harvey's (1973) work *Social Justice and the City*, the predominance of economic evaluation of environmental structures at the urban scale is quite obvious. Equipped with the powerful apparatus of theoretical Marxism combined with what he calls the 'operational structuralism' of Piaget, Harvey does not try just to use economics as one basis of an environmental descriptive theory, but as *the* comprehensive basis for that. His purely syntagmatic approach goes further, structuring the syntagms themselves through the structure of social evaluation. He does not speak anywhere about what this means in terms of syntagmatic syntax, but we may realize what that might be, considering some of his basic concepts,

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13. See Proceedings of the Seminar held by the Center for Environmental Structure in 1967.

such as 'real income', 'use value', 'exchange value' and so on. It is not our intention here to proceed in a detailed discussion about syntagmatic syntax as it may be formulated in relation to Harvey's work. Nevertheless, it will become more and more clear that his emphasis on the economic basis is considered here as being strong enough to stimulate further research on the syntagmatic nature of architectural prototypes.

It might have become apparent that in this paper we are opposed to the tendency to produce purely syntactical approaches either in describing space or in producing it meaningfully.

We presume that any descriptive theory is intended to solve some problems which have been created historically and which have influenced its origin.

It is clear that syntagm and syntax are in two ways interconnected. That is, a syntagmatic beginning produces syntaxes and the abstract syntax gets meaning in the course of syntagmatic interpretations. The important difference is that abstract formulations generally start from other scientific fields while syntagmatic ones come primarily from the problem area.

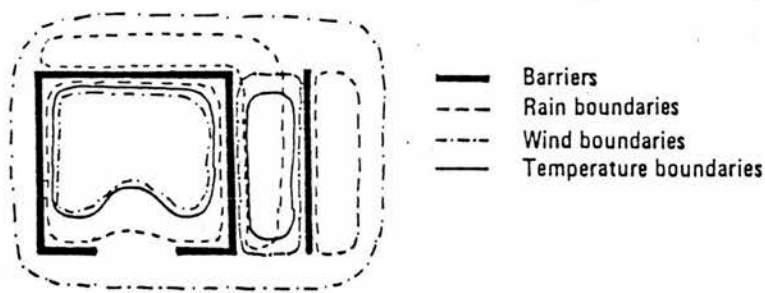
There are some questions concerned with present tendencies to establish an abstract syntax in architecture. A first question is whether abstract syntax is applicable by projection rules - similar to the Chomskyan version in Linguistics - and what are the difficulties of these applications.

The second question is concerned with whether or not there is *the* abstract syntax and, coming back to the first question, what is the degree of abstraction and applicability of this syntax. Our

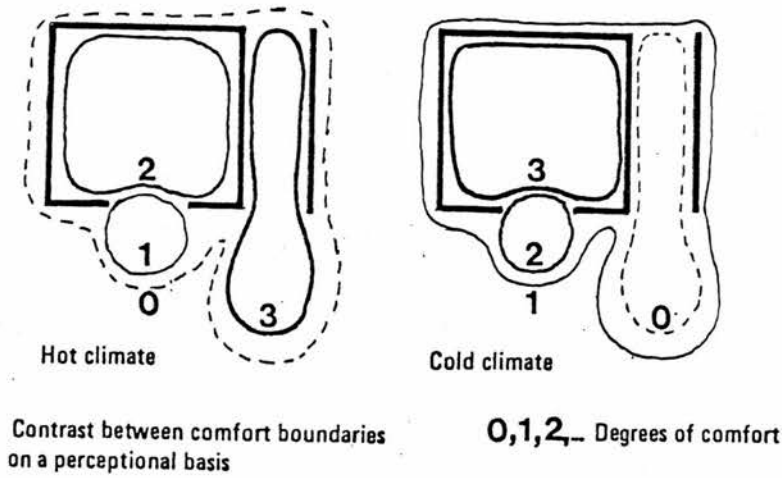
answer to this double question is simply that although practice may be using abstract formulations, it does so by producing a variety of these and that this variety is directly influenced by the problem-origin of descriptors and the systems of social evaluation of their syntagms. We have already summarized this, speaking about the syntagmatic beginning.

We shall examine some of these points as far as three descriptors of the built environment are concerned. The first two, already mentioned, are those of microclimate and networks. We shall try here to show how their syntagmatic premise produces syntaxes quite different from what current attempts - working in an abstract way, similar to those developed in Section 3 - have been trying to establish. The third, the participatory approach, is distinguished from the previous two, because it has been developed exclusively at a syntagmatic level, particularly as a movement of architectural practice. We shall try to show also what this descriptive basis could mean in terms of syntax.

Consider microclimatic descriptors in an example in which there is a specific set of microclimatic conditions (e.g. wind, rain, etc) and microclimatic structures are to be mapped only topologically. This mapping, though containing different boundaries, corresponds to a specific structure according to which internal rules connect the forms of different boundaries among themselves.



At the same level of topological representation, a syntagmatic structure may be as follows:

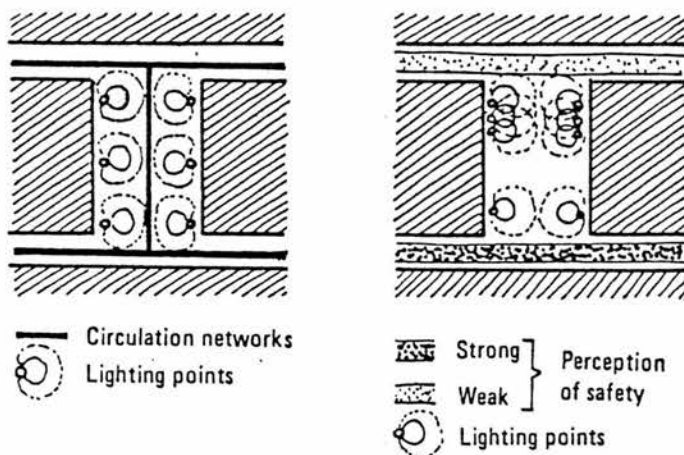


What is important here is that this structure is very flexible without altering at all the 'objective' microclimatic conditions and, consequently, the previously mentioned purely syntactic structure. This indicates that the structure, as we understand it syntagmatically, depends on the structure of the system of social evaluation and the predominancies within it. If we consider comfort, for instance, as a measure of social evaluation - in which the perception of climate by humans and their reactions are predominantly taken into account - we produce an even topologically different structure than either the purely syntactic approach or another syntagmatic approach, in which predominance belongs not only to comfort but probably to an economic basis as well. So, syntagmatic structures constitute already structured prototypes, highly valuable in architecture, which cannot be derived by applying projection rules to the kind of abstract structure shown in Section 3.

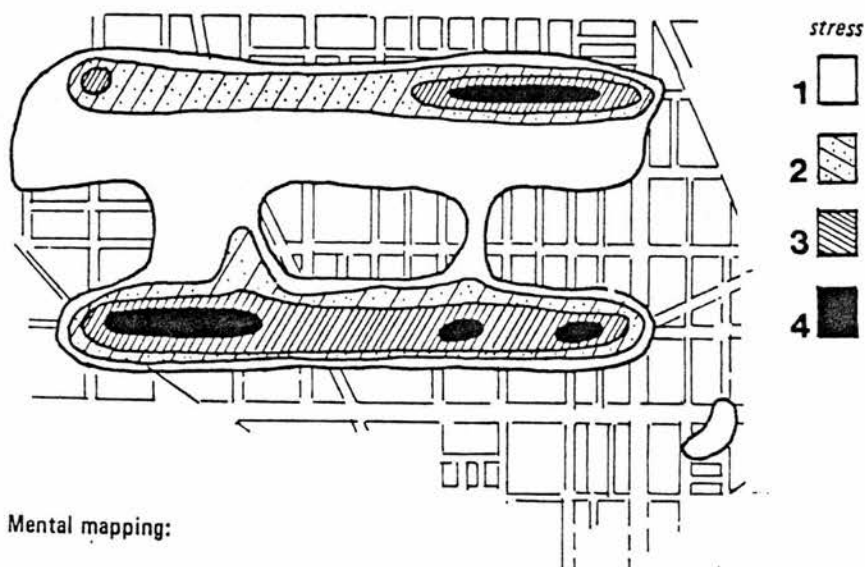
The network descriptors involved in architectural descriptive theories have also a syntagmatic character which generates syntactic

structures quite different from those which might be generated by a purely syntactic approach (as those presented in Section 3).

Consider, for example, a street network:



The street lighting example



Mental mapping:

*The perceived environmental stress surface for a portion of Philadelphia.*

In: GOULD, P. & WHITE, R., *Mental Maps*, Penguin (©1974), p. 31. (After David LEY in: *The Black Inner City as a Frontier Outpost: Images and Behavior of a North Philadelphia Neighbourhood*, University Park, Pennsylvania, Ph.D. Dissertation, 1972).



Experiments on what have been called 'mental maps' have shown how the involvement of systems of social evaluation (e.g. 'perceived environmental stress', 'preference', etc) may produce syntactic chains, totally different from the purely syntactic ones. In the street example, street lighting, for instance, is syntagmatically structured in terms of a pattern far more complicated than the purely syntactic pattern of 'homogeneous'ness' of lighting. However, transformational processes, which have been always working at the syntagmatic level in terms of microclimatic descriptors, sometimes lose their character when we try to understand them as applied to networks. This simply means that some of the technicalities of recently developed networks (e.g. electricity circuits) have not yet been entirely incorporated within the syntagmatic 'lexicon' to the extent that other networks (such as waterproofing) have been.

Microclimatic and network descriptors belong to a category in which the starting point of explanation lies nearer to the mapping procedure than to the social evaluation of a syntagmatic structure. This means that, in order to understand a structure syntagmatically through microclimatic and network mapping, we have to structure predominancies within the system of social evaluation or, in a more objective sense, to understand how the historical problem-framework has formulated these predominancies.

Obviously, this is not the only way in which descriptive theories - not only in architecture - are structured. Problems and their ideological 'behind' may influence directly at a more general level the starting point of these theories. Nevertheless, the movement towards 'Social Architecture' shows how this process may produce too generalized tendencies which do not structure the system of social

evaluation, necessary to produce the satisfactory syntagmatic levels for solving the problems. More attention, hence, has to be given to contemporary movements on architectural praxis. The 'participation movement' is one of them and we shall see how it may be syntagmatically explained.

Participation, either at a community or at an individual level, is more intelligible as 'maximum users' participation in the process of forming their environment'. Apparently, there is a variety of goals that people, who exhort users to participate, hope to achieve; starting from the improvement of the built environment and ending in what might be a political mobilization of disadvantaged communities. Similarly, the 'behind' of this practice and its ideological background vary considerably. No one can ignore that participation is often nothing more than an administrative technique or 'strategy' (as Burke (1968, p.287) calls it) closely connected with the process that Selznick (1969, p.277) identified as 'co-optation', through which an - even repressive - organization attempts to avert threats to its stability or existence. However, participation as a community-based ideological context signifies, generally speaking, the antidote against *alienation*.

Alienation is a recent phenomenon of human history; at least at the generalized scale we observe in contemporary industrial society. Marx in his first works, and especially in the *Manuscripts of 1844*, referred to it, but it is Ernest Mandel who, starting from Marx's concepts, analyzed it in a remarkable way, distinguishing among the different kinds and degrees of alienation<sup>14</sup>. He tried to answer the

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14. See pp.19-28 of Mandel's essay, *The Causes of Alienation: in Mandel and Novack (1974)*.

question of whether or not alienation is an inevitable phenomenon in industrial society, even if this society is a socialist one<sup>15</sup>. It is characteristic and convincing for the value of the bipolar alienation-participation that Mandel identifies this particular kind of practice as one of the answers to the process of disalienation.

What might such a general ideological background mean for the description of the built environment in the syntagmatic sense of the term?

Alienation and participation deal mainly with the process of production and, in our case with the process of production within the framework of which the built environment may be identified. In this sense, alination indicates that the product no longer belongs to the producer and, very frequently, this product, by being involved in the market circuit, turns against the producer himself (Marx used the concept in this context speaking about *Entausserung*). We understand this process in the built environment at a general level, distinguishing between: (a) the traditional societal forms in which the user and the architect either were identical or perceived each other perfectly, so that there was no question of alienation in the process of producing built forms, and (b) the contemporary industrial societal forms in which the built environment becomes simply a commodity and is very often characterized by what Mandel called "technical increase of needs", as an inevitable consequence of market function. Furthermore, we understand that within the context of (b), the room for creativity has been transferred from the user to the architect, recently to the industrial designer, and finally to the economic manager; that is, it

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15. See Mandel's essay, Progressive Disalienation through the Building of the Socialist Society, or the Inevitable Alienation in Industrial Society?: in Mandel and Novack (1974).

has literally disappeared.

The first level of understanding the process of alienation as the starting point of the ideological background towards participation - that is, towards progressive environmental disalienation - fulfils the semantics of the elementary structure with which a descriptive theory of built forms may be explained. Needless to say, such a syntagmatic elementary structure derives directly from economic measures and has nothing to do with the topology or any other 'purely' syntactic structure of the built environment. Nevertheless, this kind of syntagm seems to be so important that it might be, for instance, the key-concept for C. Alexander to find the context of what he called 'good fit' between form and function and would solve his basic problem of identifying the otherwise arbitrary 'needs', 'requirements' or 'tendencies'.<sup>16</sup>

It is obviously a difficult task to map such an elementary syntagmatic structure, particularly because of the lack of information to identify the degree of creativity involved in the relationship between user and space and because of the adaptability of the surface of human behaviour. Users often simply accept their environment because they do not have the opportunity to do otherwise, because they are influenced by the illusion that they have chosen it, or because they do not realize how such a lack of creativity influences their behaviour as a whole. There is no doubt, however, that evidence of attempts to escape from this passive acceptance may be found and may constitute an index for such a mapping. Inhabitants

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16. *This is not to argue that Alexander himself did not realize such inadequacies. The development of his thought is a remarkable example of successful understanding of such problems and self-correction.*

of newly constructed villages, for instance, who had been previously accustomed to a traditional way of connecting themselves with their environment, try - desperately and primitively many times, but absolutely understandably - to transform their new shells not just because the new homes do not correspond to their needs but also because they try to connect themselves with their environment.

Alienation is a context of environmental structures that we can also understand at the degree of complexity which corresponds to urban space. We have been used to explaining this phenomenon by surface characteristics such as 'the gigantic inhuman size' and 'the extent of criminality' or by deeper ones such as the property of accumulation which is attributed to the built forms by the very nature of their materials. However, it is here that the deep structural characteristic of alienation - or non participation - that is, the activities' barrier, becomes significant in two ways; as a barrier between activities and, consequently, between groups of participants and, in a dynamic sense, as a barrier between a human group and an activity under development. Contemporary cities are predominantly characterized by this attribute and their barriers may be identified at a whole scale of signifiers, starting from what might be called 'physical barriers' and ending in 'institutional barriers', such as those which eliminate access to property accumulation, etc. The way in which the citizens of Paris suddenly realized their city, in the *Commune* time (1871), as a 'festival'<sup>17</sup>, gives an example of both the deep structural identity of institutional barriers and the difficulty of recognizing it in contemporary cities.

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17. See pp.140-2 of *Villies de L'Isle-Adams'* (under the pseudonym 'Marius') article Paris as a Festival, in the *Commune* paper *Le Tribun du Peuple*: in Edwards (ed., 1971).

It would be strange if we could explain this process towards complex alienation structures starting only from the barrier between user and environmental product. We have to deal, obviously, with an economic process which is very complex to allow only architectural creativity to be the key-point towards disalienation. However, what seems to be important here - especially because we start from a strongly ideological context, which is already structured and not from a lower 'physical' level as in the case of microclimatic and network structural description -, is that we are more interested in the way in which the variations of practice lead to a variety of elementary syntagmatic structures and less in the opposite process. We shall give an example of how one of these variations produces a syntagmatic syntax of the built environment:

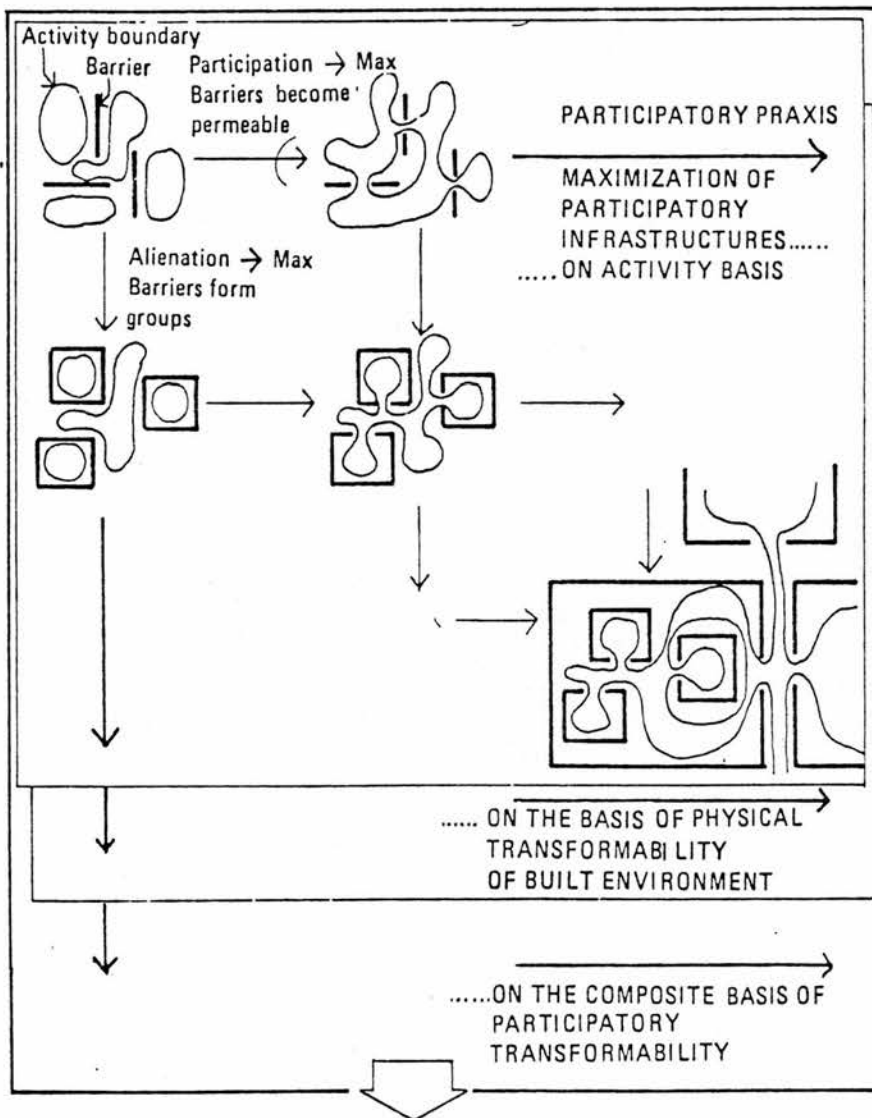
A particular interpretation of the participation movement is that the architects' advisory role is to play an important part. There are many interpretations of this role as well, from the most activist ones, in which architects become political organizers of a community, to the most 'technical' ones where architects continue to act within the traditional context of their profession. But, in this last case, the context is characterized by a tendency to equip the participants with the necessary environmental infrastructures, in order to allow them to exercise their abilities in the easiest possible way. The organization of infrastructures becomes, in descriptive theory, the recognition of them, leaving the organizational part as the inevitably following 'beyond' of the description. These 'participatory infrastructures'<sup>18</sup> may be determined by surface

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18. The term 'participatory infrastructures' looks, to a certain degree, controversial because it contains a descriptive estimation of a given reality through a non-existing condition. We may anticipate this criticism if we turn back to the basic assumption of this/



characteristics, such as flexibility of materials, the users' tendencies to participate, the institutional background for participation, etc, but it is the bipolar stable-transformable which constitutes the key for the deep elementary structure of such a description of built forms. While the city or area form would be syntactically understood - in the 'pure' mode - as a complex barrier-structure, according to such an ideologically stimulated syntax it would be understood as a structure of transformability, evaluated socially through the practice of participation:



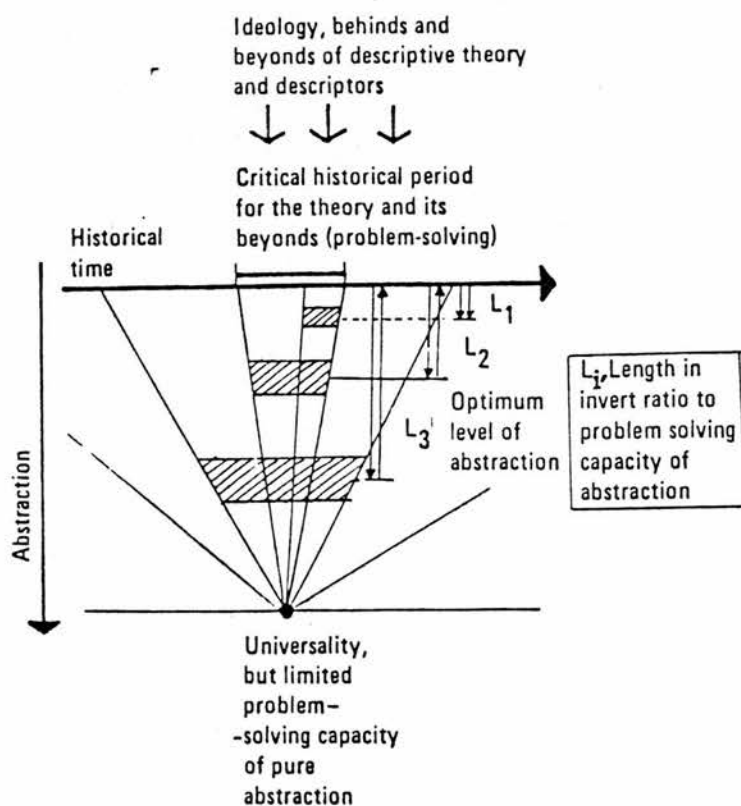
**SYNTAGMATIC SYNTAX OF BUILT ENVIRONMENT  
ON THE BASIS OF PARTICIPATORY TRANSFORMABILITY**

18 (cont). study that descriptive theories are characterized, even at the most elementary level of their components, by 'beyonds'. The very notion of syntagm would lose its meaning, if its prescriptive component were to be excluded and not to be transformed into the meaningful syntax we have already described as the syntagmatic one.



Within the context and space of this paper it has not been possible - although desirable - to discuss in detail thoughts that apparently would require a further explanation. The reader may easily understand that we have attempted only to introduce a general idea and to develop the terminology concerned with it. However, there are some points which have been repeatedly stressed and, we think, are of particular importance for further research.

A first one is concerned with the impression which might probably be concluded from the text that we completely reject the notion of abstraction in architecture. What we really tried to do in this paper was to explain the limitations of the purely syntactic approach. The strong syntagmatic character of architectural problems, combined with the high level of structural complexity of architectural prototypes, provides an intermediate level of abstraction which is capable of giving a direct possibility to solve these problems, as they emerge and are transformed historically.



When we previously explained the syntagmatic character of micro-climatic and network descriptors, we introduced one way in which the above argument on the optimum level of abstraction is adopted by practice. We have also shown the other way, when we discussed the alienation-participation syntagmatic structures. The first way is concerned with the process from the apparently syntactic to the syntagmatic while the second one with the process from an undoubtedly ideologically stimulated syntagmatic context to the syntactic chains that interpret this context. It is obvious that in reality practice works in both ways simultaneously and reaches the necessary levels of abstraction that allow these ways to contribute to each other. And, it is not the achronic 'scientific' syntax that would provide the key for establishing once and for ever these levels, for the simple reason that it is too poor and too general and too achronic to follow this complexity.

A second and final point is concerned with the particular aspects on which to concentrate further research. It is now quite clear to us that it is crucial to examine systematically the evolution of architectural prototypes within the framework of syntagmatic approach and the context of social evaluation. It is through this investigation that the structure of socially evaluated meaning may be identified and it is this structure that will enlighten this investigation as well as the solution of contemporary architectural problems. By this, we do not intend to argue that this necessity has not been recognized and elaborated by architectural thought in many different ways. We simply attempted to show how a method which at a first sight leads to abstraction can become the key for continuing this task.

## APPENDIX II

## DESCRIPTION AND DESCRIPTIVE THEORIES IN ARCHITECTURE\*

Foreword

This paper supplements the work carried out by the same authors in E.A.R./3 under the title "Description and Descriptors in Architecture"<sup>1</sup>. In that article we have suggested that further research on this subject should be mainly orientated towards examining systematically the evolution of architectural prototypes within the framework of 'syntagmatic approach' and the context of 'social evaluation'. However, instead of carrying out this task, in a necessarily short paper, it appeared to us that it would be useful to develop further the general idea itself and to clarify the terminology concerned with it which, as the discussion of the E.A.R./3 article has proven, was obscure on some points. These points are briefly discussed in the introduction and elaborated in the text of this paper.

The present study is divided into the following two sections:

1. Notes on the identity of environmental structures.
2. Notes on the terminology concerned with the dynamics of environmental structures.

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\* *The contents of this appendix appeared originally in a collective paper written by the author of this thesis and his colleagues, Dr T. Kosiopoulos and Dr T. Maravelias. This paper has been published, under the same title, in Edinburgh Architecture Research (E.A.R.), Volume 4, 1977, pp.23-52, and is now reproduced here in its entirety. Several minor modifications, especially in terms of footnotes, have been rendered necessary following the adoption of the same general system of referencing authors and so on employed throughout the main body of the thesis.*

1. *See Awadalla et al (1976). For brevity, we shall refer to this article as the "E.A.R./3 article" throughout this study. [This E.A.R./3 article is now shown as Appendix I to this thesis.]*

Needless to say, there is no way of understanding the content of this article outside the framework established in E.A.R./3.

### Introduction

In the E.A.R./3 article we concentrated on discussing the problems of establishing a theory for the investigation of the built environment within a structural framework. By doing so, we outlined the methodological limitations of both purely syntactic and purely semiological levels of approach to deal comprehensively with both the logical and the semantic complexity of architectural structures. We have attempted, also, to show - through examples taken from each of the authors' individual research - the 'syntagmatic' character of these structures and, furthermore, that it is imperative for any descriptive theory concerned with them to reach a level of 'optimum abstraction' and to keep the explanation within both its historical framework and the social evaluation of environmental structures.

As mentioned in the foreword, there are two major areas which, we think, need further clarification and development. First, the area of the identity of a structure (because of the strictly environmental point of view we took in the E.A.R./3 article) and second, the area of the dynamics of a structure (because of both the consequences of the enlargement of the first area and the limited discussion in E.A.R./3 about it).

The key-concept for the re-investigation of the identity of architectural structures and, therefore, for the descriptive theories concerned with them, is the 'descriptive dimension'. Structures in

E.A.R./3 have been considered more or less under the assumption - though not clearly stated there - that their predominant representation and, consequently, the starting point for their description is to be found at the level of the environment. The concept 'descriptive dimension' means simply that, apart from the purely structural analysis according to the deepness and the complexity chains, there is room for investigating different representations of the structures - such as at the activity or the institutional levels - which sometimes are nearer to the historical origin of them.

This consideration implies a whole new area for discussion about the 'identity' of a structure intelligible at the environmental level. We shall be trying to identify some points of such a discussion in connection with the dynamics of structures and especially the potential for their transformation.

The potential and the nature of transformation are exactly the second area this article deals with and the key-concept to this is the notion of 'contradiction'. The simplified form of our central argument is that transformations are caused by contradictions within the structures and it is our task to identify and classify their nature.

#### 1. Notes on the identity of environmental structures

The term 'structure' in architecture has gradually acquired a polysemic meaning, the complexity of which makes its use quite ambiguous. The traditional meaning and use of the term associates the concept of structure either with the loadbearing parts of a building or, in a more general sense, with anything built by man, from

a house to a pyramid<sup>2</sup>. An *imported* use from other conceptual domains, influenced by the development of 'structuralist' thinking, associates structure with a number of other concepts like 'system', 'whole', 'coherence', 'set of relationships', etc., beyond the environmental level - though not yet necessarily of a syntagmatic character.

As is the case with the general epistemological use of the term 'structure'<sup>3</sup>, its imported use in architecture is not clear and consequently the conditions for applying it to a given reality are not well understood. The multiplicity of connotations attributed to it doubts both the existence of a single definition and a single methodological orientation, which could be termed 'structuralist' and, hence, the conceptual confusion surrounding the use of the term in the general epistemology and consequently in architecture.

In general, differentiations in the use of the term might be considered as taking place by the different values applied to it according to two major semantic bases:

- (i) The conditions under which a structure can be applied as such:  
For Piaget (1971, p.5), for instance, conditions of "wholeness", 'transformation' and 'self-regulation' are applied to define 'structure' as a system of transformations under some well-defined transformational rules. Two extreme examples according to this basis may be given; the 'mathematical group' (which Piaget (1971, p.19) considers as the finest prototype of his definition of structure) and, a concept in general use, the 'social structure' where no such formal conditions may necessarily

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2. See, for example, the definition given by The Penguin Dictionary of Building (1974 edition)

3. For a detailed exposition, refer to Boudon (1971).

be applied<sup>4</sup>.

- (ii) The degree of abstraction applied to a certain reality which is necessary in order to understand a structure. This basis leads automatically to the syntactic components of the "deep structure" and it is identical in its practical application to the Chomskyan linguistic model of grammar (E.A.R./3, pp.55-6). According to this basis, structures are to be identified either at the abstract level of deep structure<sup>5</sup> or, alternatively, at a surface level of the observable reality. One attitude identifies a structure at a surface level under the condition that there is a deep level which is itself the structure, while a second attitude accepts the deep level analysis as inevitable without imposing conditions to identify a structure at a surface level.

Our position, reflected in E.A.R./3 and firmly held here, is that there is no objective way of imposing any conditions to define a concept of structure and, afterwards, using this concept for explaining a particular set of architectural realities. Obviously, the structural identity may be, in some cases, strongly implied by conditions applied to the environmental image of these realities (e.g. a neighbourhood as a structure), in other cases, to the institutional image (e.g. a hospital or a university as a structure) and, in other cases, to a complex image (e.g. a town as a structure<sup>6</sup>).

Before we introduce and discuss the concept of 'descriptive

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4. *'social structure' even considered in its broader sense may well depend upon higher structures, for instance like those of 'roles' and 'character structure'. For an explanation of this dependence, see Gerth and Mills (1957).*
  5. *Compare with the concept of 'space syntax' developed by Hillier et al. (1976).*
  6. *See, for instance, Lagopoulos' (1973) definition of 'town' as a semiological structure.*



dimension", it seems that it is necessary to elaborate further on the distinction between description and descriptive theories we put forward in E.A.R./3 (p.39); that is:

"Descriptors are the components of descriptive theories. In other words, they constitute the basis according to which a description may be implemented. A descriptive theory may consist of either one predominant descriptor which is being considered as the most important one, or a set of descriptors which supplement each other in a structural way within the framework of a descriptive theory. Comprehensiveness, therefore, emerges as one basic property of descriptive theories. However, comprehensiveness is not a property that a descriptive theory may technically acquire only by combining descriptors in isolation from both its historical origin and its structural context."

Moreover, we took the view that:

"... 'description' is used in its broader sense of 'explanation'. Within this context, description automatically implies both a 'behind' as well as a 'beyond' in terms of its historical evolution and its practical applications".

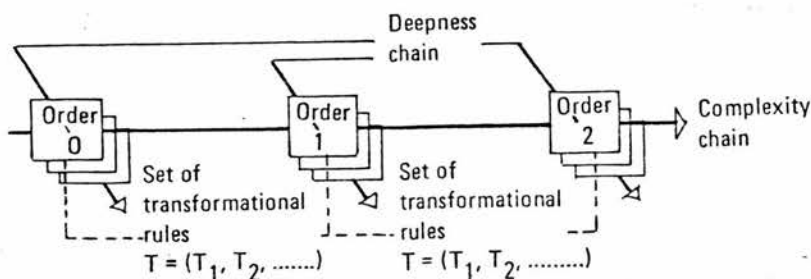
Popper illustrates, in his own philosophical context, the major assumption in our thesis above. That is, comprehensiveness - in Popper's terms 'understanding' - is unavoidably related to 'problem-solving' when complex structures like those of his 'objective third world' are concerned (Popper, 1972, p.168). He emphasizes the importance of description, considered in its broader sense of explanation, as being the aim of science and, furthermore, he argues that actions and, therefore, history can only be explained as problem-solving (Popper, 1972, p.191).

However, in this study we further consider explanation to be closely related to the structure of descriptors and especially to the transformation 'within' and 'between' the different descriptive images generated by complex multidisciplinary structures. But, before we proceed to an extensive discussion concerned with the

above argument, it is important to consider first what the general implications of the concept of descriptive theory in social sciences might be.

'Descriptive theory' is an achievable, if not common, reality in social sciences. That is, because, as Althusser (1972) emphasizes, descriptive theory is the 'irreversible' beginning and 'transitional' phase of a theory. This becomes obvious considering that in social sciences the dependence of theory on practice is very strong. Both Harvey (1973) and Althusser (1971) have emphasized the dependence of theory on practice speaking about 'theory as practice' and 'theory as specific form of practice' respectively. It becomes, therefore, obvious that, since architectural structures are products of a specific form of social practice, the dependence of descriptive theories concerned with these structures on this practice is imperative.

Now, it is important to examine the relationships between three chains, all of which might be considered as containing distinguishable images of a structure with an environmental representation. In E.A.R./3, we spoke about two chains, the 'deepness' and the 'complexity' chain. Schematically, these are represented by the following diagram:



The structural dimensions of descriptors,  
after the E.A.R./3 article, p.54.

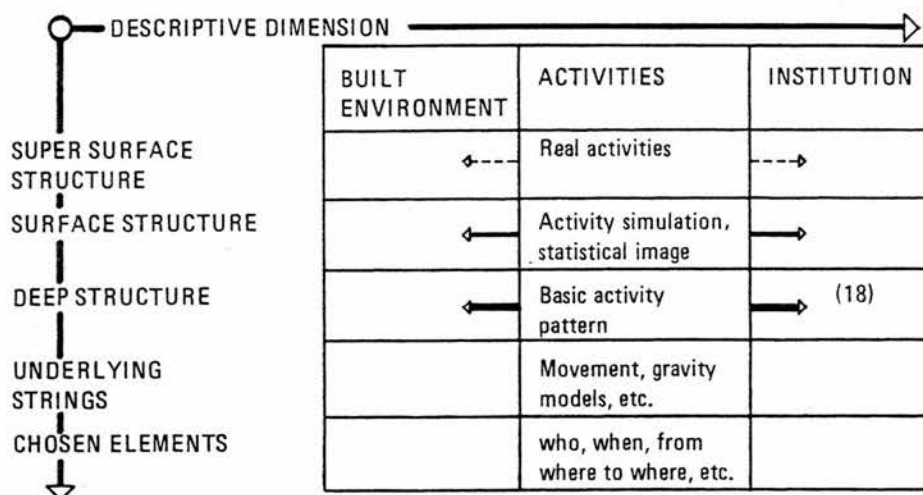
The syntactic character of the complexity chain is, obviously, strong. Complexity chains are to be identified in the decision-making process but all of them are developed within the framework of a given substance. For example, a university complex is derived from accumulating elementary activity patterns. The transformational rules of a complexity chain deal with the transformations from the elementary to the more complex, although in the decision-making process it is sometimes clear that 'elementary' might well mean a basic pattern for the whole master plan.

The deepness chain is a semantic chain connecting deeper levels of the structure with surface ones by means of transformational rules. In the E.A.R./3 analysis, conducted within strict disciplinary architectural configurations, this chain was represented by the following diagram:

| DEEPNESS CHAIN                            | ARCHITECTURE  |
|---|---|
| SUPER SURFACE STRUCTURE                   | Building  |
| SURFACE STRUCTURE                         | Building compartmentalization +<br>+ activities' organization, etc. |
| DEEP STRUCTURE                            | Basic organization of building<br>(enclosure + access, etc.)        |
| UNDERLYING STRINGS<br>(RULES OF THE BASE) | Building physics, etc. +<br>+ balance, etc.                         |
| CHOSEN ELEMENTS                           | Materials, etc.   |

However, in the case of structures whose origin might be found at more than one disciplinary area, it is possible to identify, even at the deeper level, other descriptive tools (e.g. organization of activities, etc). Especially, in structures the origin of which is mainly institutional - like universities - the analysis of the deepness

chain may be as follows:



\*See note 7

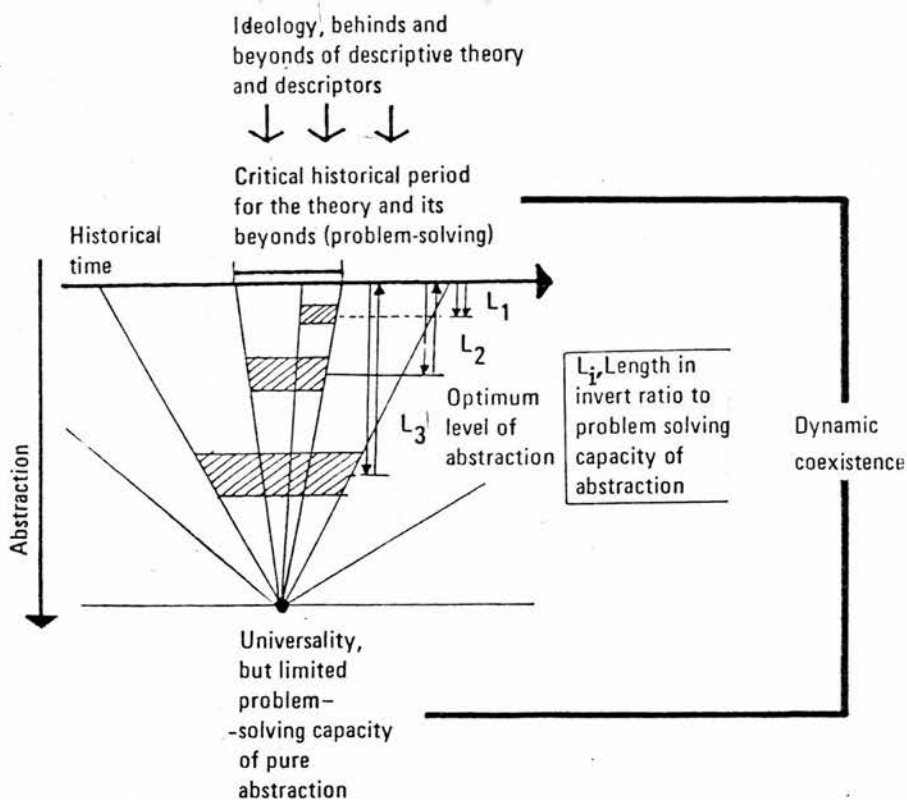
The chains produced by the involvement of 'descriptive dimension' in the diagram above are different in terms of the substance of the available information, but this difference is minimized at the deeper levels where the cohesion of descriptors is maximized. Semantic levels, therefore, are established and explained in reference to both the deepness and the descriptive dimension. In summary, descriptive chains necessarily supplement both complexity and deepness chains when descriptive theories about multidisciplinary structures are concerned.

In social sciences and particularly in architecture, the involvement of the semantic dimension in descriptive theories attributes to them their subjective character. It would have been quite ambiguous to claim that a descriptive theory which has an historical origin, a problem-solving capacity and aims at ideologically influenced purposes of the practice which it follows, might be considered under any

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7. *The arrows on the diagram illustrate the different degrees of cohesion between the representations of the structure. The deeper levels are much easier to relate than the surface ones.*

criteria as 'objective'. What might be objective is exactly this realization about the subjective character of descriptive theories. Accordingly, it is quite natural to expect that the logical tools - in our case the structural analysis - which are used to analyse and even to construct such descriptive theories have to be objectified.

Instead of speaking about the 'subjectivity-objectivity' bipolar, it might be more productive to raise the question of the degree of abstraction of a descriptive theory and its subject. The 'dynamic coexistence', reflected in what we called in E.A.R./3 'optimum level of abstraction' between the abstract logical tools and the historically and ideologically originated problems, constitutes a fundamental characteristic of the kind of descriptive theories we are talking about in this study (see following diagram).



Adapted from E.A.R./3, p.74

Both Piaget's 'reflective abstraction' and Harvey's 'operational structuralism' based on Marxism - which have been used as models in E.A.R./3, contain similar conceptual pairs. While 'reflective abstraction' and 'praxis' are abstract and achronic, the descriptive theories they generate are ideologically manipulable in terms of practice and historically emerged in terms of description. Accordingly, the concept of 'syntagmatic syntax' reflects also the same coexistence. As mentioned in the E.A.R./3 article (p.62):

"... the syntagmatic approach to a structure includes the social evaluation of even the elementary deep structures."

The concepts of 'structure', 'elementary' and 'deep' reflect the abstract character of the linguistic model and the concept 'social evaluation' (equivalent to 'meaning') reflects the historical and ideological origin of description.

Having examined the type of descriptive theories with which we are involved in studying multidisciplinary structures, it now becomes significant to study the question of how such structures are to be identified by these descriptive theories. Theoretically, the 'identity of a structure' is reflected in a kind of structure of the different descriptors involved in a descriptive theory. It is easy to imagine that this structure of descriptors is transformed on both an historical and a geographical basis. It is also easy to imagine that such transformations correspond to the changes of what in E.A.R./3 has been called the 'system of social evaluation' of a structure or the 'pragmatic meaning' of it.

However, 'structure of descriptors' may well represent what in E.A.R./3 has been called the 'social evaluation' of a structural

subject. What is implied here is that such an evaluation is 'internal' in the investigation of a subject and, consequently, present in the articulation of the logical tools of a theory and especially in its descriptive dimension. Thus, we may argue that, when the structure of descriptors is broad enough to reflect the system of social evaluation which is in operation at a certain historical moment and comprehensive enough to explain adequately the transformations among the different descriptive images of the structure, then and only then does such a set of descriptors constitute a descriptive theory. This 'structural role' of social evaluation is greatly manifested in the construction of predominancies among the different descriptive images present in the descriptive dimension. In this way, the institutional, activity or environmental image - which, among other alternatives, constitute the descriptive dimension in this study - may become predominant within an explanatory framework which a descriptive theory acquires, depending on the particular system of social evaluation by which the different descriptors of the theory have been structured.

In summary, the identity of the structure of a descriptive theory defines a structural approach in which social evaluation becomes the basic tool for the development of the descriptive theory. What is implied by this is that the transformations from one descriptive image to another cannot be considered in isolation, but only within a system of social evaluation. The whole series of transformations, within a given period, represents the system of social evaluation as applied to the structure at that time.

To understand the structure of descriptors we have to understand possible transformations from one image to another, other than



the systemic ones introduced by the 'hierarchies' of modern practice. In the E.A.R./3 article's analysis, transformational rules took the form of a commutative square - that is, they, being opposite to each other, supplement each other from the deep-elementary to the surface-complex level. Such rules were transferred into different descriptors (microclimatic, network, etc), but their abstract basis was common (continuity-max, discontinuity-max, channel barrier, etc) (E.A.R./3, p.54). Apparently, at higher levels, the systemic logic between descriptors appeared inevitable. But, even within this framework, it is possible at least to identify the causes of the transformations of a structural subject, in terms of the contradictions or 'anomalies' between the different images. The following discussion on the dynamics of environmental structures makes it obvious that design and planning action partly originate by the realisation of the non-correspondence between the images of a structure at different descriptive levels (e.g. environmental, activity or institutional level) and partly by the contradictions appearing within the image of a structure at a single descriptive level.

## 2. Notes on the terminology concerned with the dynamics of environmental structures

A basic assumption in the theory which is based upon the philosophical dimension of Marxism and is known as 'materialist dialectics' is that the fundamental cause of the development of a structure lies in the contradictions within the structure itself, under a set of given conditions. Mao (1975, pp.313-6) has expressed this central point in his familiar epigrammatic way writing that:

"Contradictoriness within a thing is the fundamental cause of its development, while its interrelations and interactions with other things are secondary causes...contradiction has a twofold meaning. One is that contradiction exists in the process of development of all things, and the other is that in the process of development of each thing a movement of opposites exists from beginning to end."

The general discussion about 'contradictions' could be very interesting, especially when it is concerned with the different interpretations and analyses of this concept. We do not intend to enter into a detailed discussion about the general epistemology of contradictions which is, undoubtedly, a very broad one; instead, we shall present certain illustrative views which offer a preliminary basis that we found useful in the conceptualization of the notion of contradiction and its extension to the study of the dynamics of environmental structures in this paper.

One basic point of such analyses, is the differentiations made between principal and secondary contradictions. Mao's attitude on this might be concluded from the following extract:

"The fundamental contradiction in the process of development of a thing and the essence of the process determined by this *fundamental contradiction* will not disappear until the process is completed; but in a lengthy process the conditions usually differ at each stage. The reason is that, although the nature of the fundamental contradiction in the process of development of a thing and the essence of the process remain unchanged, the fundamental contradiction becomes more and more intensified as it passes from one stage to another in the lengthy process. In addition, among the numerous major and minor contradictions which are determined or influenced by the fundamental contradiction, some become intensified, some are temporarily or partially resolved or mitigated, and some new ones emerge; hence the process is marked by stages." (Mao, 1975, p.325; our emphasis).

In reference to Mao's work Althusser (1971) defines contradictions in terms of principal and secondary ones. For the first, he prefers the term 'general contradictions' and defines it as (p.99):

"... the contradiction between the forces of production and the relations of production, essentially embodied in the contradiction between two antagonistic classes..."

He also writes that this 'general contradiction' cannot of its own explain either a 'revolutionary situation' or the 'rupture and triumph of the revolution'. He specifies that, in addition to this general contradiction, there must be an accumulation of what we might understand as 'secondary contradictions', which are not necessarily solely derived from the same base as the general contradiction though they might be affected by it. He says (p.100):

"... They derive from the relations of production, which are, of course, one of the *terms* of the contradiction, but at the same time its *conditions of existence*; from the superstructures, instances which derive from it, but have their own consistency and effectivity, from the international conjuncture itself, which intervenes as a determination with a specific role to play." (His emphasis)

As opposed, to a certain degree, to Althusser's approach, Foucault classifies contradictions in terms of the history of ideas and discourse, distinguishing between contradictions of appearance (of discourse), and contradictions of foundation, which give rise to discourse itself. In this context, it is interesting to look at one quite long passage from his *Archaeology of Knowledge* (1972). He writes (pp.150-1):

"... the fundamental contradiction emerges: the bringing into play, at the very origin of the system, of incompatible postulates, intersections of irreconcilable influences, the first diffraction of desire, the economic and political conflict that opposes a society to itself, all this, instead of appearing as so many superficial elements that must be reduced, is finally revealed as an *organizing principle*, as the *founding, secret law that accounts for all minor contradictions and gives them a firm foundation*: in short, a model for all the other oppositions. Such a contradiction, far from being an appearance or accident of discourse, far from being that from which it must be freed if its truth is at least to be revealed, constitutes *the very law of existence*: it is on the basis of such a contradiction that discourse emerges, and

it is in order both to translate it and to overcome it that discourse begins to speak; it is in order to escape that contradiction, whereas contradiction is ceaselessly reborn through discourse, that discourse endlessly pursues itself and endlessly begins again; it is because *contradiction is always anterior to the discourse*, and because it can never therefore entirely escape it, *that discourse changes*, undergoes transformation, and escapes of itself from its own continuity. Contradiction, then, functions throughout discourse as the principle of its historicity.

This history of ideas recognizes, therefore, two levels of contradiction: that of *appearance*, which is resolved in the profound unity of discourse; and that of *foundations*, which gives rise to discourse itself. In relation to the first level of contradiction, discourse is the ideal figure that must be separated from their accidental presence, from their too visible body; in relation to the second, discourse is the empirical figure that contradictions may take up and whose apparent cohesion must be destroyed, in order to rediscover them at last in their irruption and violence. Discourse is the path from one contradiction to another: if it gives rise to those that can be seen, it is because it obeys that which it hides. To analyse discourse is to hide and reveal contradictions; it is to show the play that they set up within it; it is to manifest how it can express them, embody them, or give them a temporary appearance." (Our emphases)

However, contradictions as such do not, by all means, constitute a comprehensive concept totally sufficient for interpreting the transformations of structures, particularly of those whose images may be identified at different descriptive levels. The mechanisms of transformations are very complex, to such a degree that they allow only the connection between 'contradiction' and 'potential for transformation' to be made. Contradictions are quite understandably causes for change of a structure, but the path from the cause to the real nature of change is very long and quite complicated. Nevertheless, what seems to be possible is to identify, in an empirical and predominantly *a posteriori* way, the core of contradiction within the transformation and to distinguish between the significance and the eventual marginal role of it for the transformation itself.

It is our thesis here that a descriptive theory in which there are various descriptive levels - such as the 'environmental',

'activity' and the 'institutional' ones - articulates respectively the kind of contradictions which are eventually identified as to be connected with the transformations of the structure as a whole. Apparently, contradictions between the different images of the structure at those descriptive levels are by no means impossible. On the contrary, experience has repeatedly proven that such contradictions constitute fundamental causes for 'design action'. It is logical, however, to expect that such 'inter-level' contradictions (for example, an environment which is not corresponding to a changing activity image or an institutional framework which is far beyond an environmental image or much behind an activity one) do express the existence of more general contradictions which are more intelligible at higher descriptive levels. It is dangerous, nevertheless, to exaggerate the capabilities of design action. Since design action is a specific kind of social practice, it is limited not only by its institutionalization within a given mode of production, but also by the very immediate nature of the phenomena it is dealing with. When it aims at resolving the inter-level contradictions, that is, contradictions between images of a structure, design action has, as a rule, a limited potential for transforming the structures as wholes and for resolving leading contradictions - even if the expression of those inter-level contradictions is sufficiently clear.

In particular, when we consider structures in terms of their environmental image, it is possible to distinguish a specific category of contradictions caused by the differentiation of substance between the descriptive levels. We prefer to call this category of

contradictions 'normal anomalies'<sup>8</sup>, the most common kind of which are those between the stable environmental and the changing activity image of a structure. Normal anomalies of this kind, on the one hand, and conservative design, on the other, are perhaps the most typical bipolar in architectural design action.

Normal anomalies appear between the different images of a built environment structure produced by different descriptors irrespective of the level of complexity and deepness at which the structure is looked at. The objectivity of the theory, that is, of the descriptors chosen, is reflected on the ability of these 'anomalies' to represent real causes for transformation of the structure. Normal anomalies also represent, by the degree of their realization and resolution, the system of social evaluation of the structure at a specific historical moment.

In this sense, anomalies between the different images of a structure can function as potential for transformation of the structure as a whole. Thus, the supposed transformational rules between the different images of a structure are eventually characterized by such anomalies.

Is there any way to understand these transformations in terms of the syntagmatic syntax and its commutative square?<sup>9</sup> By definition such a syntax would incorporate characteristics of an historical moment such as the acceptance of a given set of descriptors, the

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8. Kuhn's (1970) epistemology is a clear example of the use of the notion of 'anomaly' as the fundamental law on which scientific knowledge is developed. Kuhn's theory, in short, is that scientific paradigms (within the framework of which 'normal science' is taking place), being historically originated human products, are transformed through the potential which is included in them in the form of 'anomalies', as he calls them. Anomalies are the contradictions between what a paradigm should imply for the investigation of a structure and what the investigator observes.

9. For an explanation of the notion of commutative square and its particular use in this work, see E.A.R./3 and also pp. 368-76.



realization of 'anomalies' among the different images of a structure and an 'hierarchy' according to which such anomalies are practically manipulated.

It is possible, however, to imagine from the first moment that the contradictions which are involved as transformational potential in such a syntax have a clear dual identity. They are either what we call 'leading' contradictions which are to be found in different forms, *within* each descriptive image of a structure or diachronic contradictions caused by the lack of correspondence *between* the different images, that is, 'normal anomalies'. Accordingly, the advantages of such an analysis would be that the systems of social evaluation are included in the expressional tools of the syntax and are not external to it as they were in E.A.R./3. In this way, therefore, social evaluation becomes quite naturally a dialect of understanding the multidisciplinary defined structure and not a language for a particular discipline like architecture.

Leading contradictions, as opposed to normal anomalies, are more general and less circumstantial. The adjective 'leading' means simply that they are present and recognizable (in different forms, perhaps) at more than one image of a built environmental structure. The character of leading contradictions depends on the individual attitude of the architect or planner, on his general position against the particular structure under investigation and on the particular system of social evaluation employed in the investigation of this structure. In terms of syntagmatic considerations of a complex structure, leading contradictions are determined through predominancies structured within a broader system of social evaluation. These predominancies - especially because of the *immediacy* of architectural



actions required - are able to ascribe an institutional, activity or environmental character to leading contradiction or to hierarchize leading contradictions of different character according to both the assumptions and objectives of the study and the assumed role of the architect or planner.

CHARACTERISTICS OF NORMAL ANOMALIES AND LEADING CONTRADICTIONS AND THEIR EVALUATION IN TERMS OF DESIGN ACTION

| NORMAL ANOMALIES  | LEADING CONTRADICTIONS  |
|---|---|
| a. Diachronic contradictions caused by differentiation of substance and, consequently, lack of correspondence <i>between</i> different descriptive levels of a structure.   | Present and recognizable in different forms <i>within</i> each descriptive image of a structure. More general and less circumstantial than normal anomalies   |
| b. More objectified, since the objectivity of the descriptive theory is reflected in the ability of N.A. to represent real causes for transformation of a structure.  | More subjective and ideologically influenced since they depend heavily on the individual attitude and the general position of the architect or planner against the structure he investigates.   |
| c. High potential for transformation of a structure in terms of design action because normal anomalies, due to their nature, always suggest to a certain degree the spatial implications of their resolution (e.g. environmental-institutional, environmental-activity, and activity-institutional images). | Limited potential for transformation in terms of design action due to their ambiguity in suggesting ways for their resolution. This ambiguity stems, mainly, from their representation in very generalized form and only within one descriptive image of a structure. |
| d. Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominant descriptive images of this structure.   | Related to the system of social evaluation involved in the investigation of the structure, in terms of the ability of this system to construct predominancies of descriptors within each descriptive image of this structure.   |

From the arguments previously given and summarized in the table above the structural role of social evaluation can be seen in terms of:

- (a) Identifying the structure and hierarchy of normal anomalies and leading contradictions, thus defining transformation both in terms of its nature and its context within a structured whole.
- (b) Arranging the logical tools of the descriptive theory and, in particular, the descriptive dimension of the structured whole by influencing the theoretical conception of the problem and indicating particular design action, thus operating within a given mode of 'theoretical practice'.

Therefore, the resolution of contradictions - either in the form of design action of a conservative character, or as a revolutionary process, especially concerning the leading contradiction - takes place within an historically determined system of social evaluation which itself is contradictory and characterized by such leading contradictions.

According to a fundamental assumption of this study - especially discussed in E.A.R./3<sup>10</sup> - description as a whole reflects this system of social evaluation and, therefore, the contradictions within the context of its subjectivity. Although it is an exaggeration to claim that this subjectivity can continuously change the nature of the logical tools that a descriptive theory uses, on the other hand, it is necessary to admit that these tools express different concepts at different times. They should, in our case,

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10. See E.A.R./3, pp.74-5.

without losing their abstract and generalized character, be articulated in order to include a 'contradictional' interpretation of the transformations of structures which are of specific interest for the study of the built environment. It seems, therefore, that there is room here for an interesting task for the theorist: that is, to check his tools and the concepts which are involved in any dynamic consideration of environmental structures from this particular point of view.

In the discussion that follows we have tried to illustrate some terminological aspects concerned with the present contradictional interpretation of the dynamics of environmental structures through examples taken from each author's work and from other current architectural theories.

Some of the most predominant and architecturally significant contradictions inherent in certain ecoclimatic descriptors, like 'comfort', can only be identified if we consider carefully the different descriptive images generated by ecoclimate<sup>11</sup>.

Comfort is usually considered as an environmental descriptor. However, at a deeper level of analysis, comfort description can be seen as deriving from a broader institutional framework within which the general human control upon nature is organized through technology and social organization which, eventually, in a wider context,

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11. *'Ecoclimatic' phenomena as opposed to 'microclimatic' ones are considered here to be those concerned with the semantics of the physical fields of climate and microclimate, that is, with the human perception, understanding and evaluation of the climatic conditions of the built-environment. In such context, therefore, the ecoclimatic phenomena cannot be defined by their microclimatic characteristics alone or describable in a purely climatological or meteorological language, but only within a much broader conceptual framework where the processes of producing the architectural environment together with the semantic dimensions of the climate of the built-environment are taken into consideration.*

facilitates the intellectual and economic dominance of man by man<sup>12</sup>. Banham (1969) among others, has successfully emphasized the institutional image of environmental descriptors arguing that:

"A large part of that ease and leisure comes from the deployment of technical resources and social organizations, in order to control the immediate environment: to produce dryness in rainstorms, heat in winter, chill in summer, to enjoy acoustic and visual privacy, to have convenient surfaces on which to arrange one's belongings and sociable activities."  
(Banham, 1969, p.18)

Man's struggle to free himself from constraints imposed by the environment in favour of needs and activities extended beyond human survival has always manifested itself at an institutional level in which control over the environmental forces, such as climate, is *controlled* by profit through particular socio-economic and political structures. For instance, the unjustified isolation and description of comfort merely on environmental grounds facilitates, in the best possible way, the use of comfort as a commodity<sup>13</sup>.

Within the institutional image of comfort leading contradictions of the following type are easily recognizable. On the one hand, there is the general demand to naturalize the environment through particular means of production, planning and social organization in order to achieve equal standards of comfort and amenity, and on the other, the means of achieving comfort are totally dependent on a growing technological and industrial society in order to maximize capital profit. However, as far as design action is concerned, it could be rather philosophical and, in any case, impractical to claim that the perceptual organization and functioning of the built

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12. *This view corresponds to the analysis which has been given by H. Marcuse and J. Habermas. See Habermas (1971); particularly Chapter 6, "Technology and Science as Ideology", pp.81-122.*

13. *See E.A.R./3, p.40.*

environment is generated by such leading contradictions of deep political character which dominate the institutional image of ecoclimatic descriptors. In fact, design action is generated only when inter-level contradictions between the different images of ecoclimatic descriptors (that is normal anomalies) and especially those between 'environmental-institutional' and 'environmental-activity' images are manifested within the environmental structure. It is easy, for instance, to imagine that normal anomalies between the environmentally defined comfort problem-situations and the economic functioning of comfort commodities account for a large part of the present deterioration of the urban environment, as far as its ecoclimatic characteristics are concerned (e.g. increasing environmental pollution, energy crisis, class differentiation in comfort amenities, artificially created technological inadequacy for utilising cheap natural energy and so on, etc) and, therefore, these anomalies create particular causes and implement certain strategies for design action.

Normal anomalies of the 'environmental-institutional' type can be recognized, for instance, in the commonly accepted requirement to maintain the present comfort standards by means of conserving energy resources on the one hand, and on the other, to increase control over comfort operating without consideration of limited energy resources since this control is primarily *controlled* by profit. Also, this is reflected in the contradictions inherent in the process of achieving comfort through an integrated consideration of the climatic forces which requires the ability to act on an environmentally defined spatial 'totality' on the one hand, and, on the other, the institutional demand for a disintegrated private

space which prevents spatially integrated measures to be taken for achieving comfort or introducing solutions to other ecoclimatic problems.

Finally, normal anomalies of the 'environmental-activity' type, like, for instance, those appearing between the definition of a uniform comfort-zone without reference to the multi-usable character of space or to the cultural character of ecoclimate, and the functioning of activities with different climatic requirements organized within a uniformly considered ecoclimatic space are, also, very significant from a design action point of view.

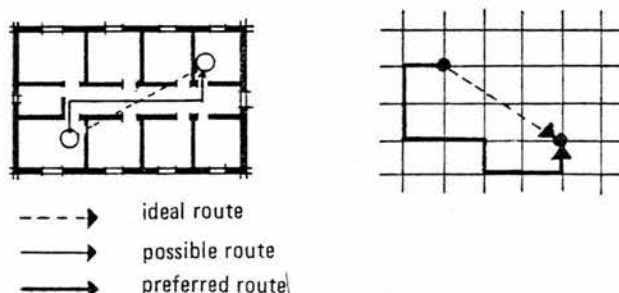
Similarly, we can see how the use of the 'grid' in layout design operates as a generator of contradictions. The main conventional communicative tools of design - the plan, section, elevation, etc - are basically provided by the Euclidean conception of space, where the shortest distance between any two points is the straight line.

However, due to restrictions imposed by the use of grid layouts and the insertion of barriers along the grid lines, for purposes of construction economy, building users are obliged to use building space in its 'hodological' nature (space of possible movement)<sup>14</sup>. In this sense, any movement route taken from one place to another is far from being of a direct straight line nature. In most cases, however, it will be in a series of perhaps broken lines; the decision, which lines to follow along the circulation route, is not necessarily always the optimal one. In fact, there is no way to guarantee this

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14. *For a discussion concerned with the definition of the concept of 'hodological space', refer to Norberg-Schulz (1971, p.22).*

will ever be possible because the 'preferred route' is dependent on a much broader system of evaluation than the one provided by distance minimization or travel cost alone.



This leads us to doubt the starting premise and ultimate objective of the majority of the present generation of analytic layout design methods. The starting premise of these methods is man's presumed greatest need (based on the 'principle of least effort') for the minimization of travelled distances in a metric sense. The grid was adopted as a convenient start. Grid geometry, based on Euclidean geometry, asks for shortest distances to be in direct straight lines. But, as we have just argued above, it is impossible in a situation which is affected by many restrictions imposed by grid barriers to travel in direct straight lines. Hence, and at the very base of its formulation, the route optimization problem in building layout (or in planning, generally) faces an obvious logical difficulty which it has only been able to surmount, partially, through a series of simplistic assumptions. These simplistic assumptions eventually forced many theorists into elaborate ways of problem formulations,



only to find them insoluble even by using the fastest computer.

A major justification for the development of these methods is that organizations and, hence, buildings are becoming more and more complex, yet the solutions offered are of the most simplistic kind and firmly held in a deterministic world that overlooks change (i.e. transformation) which is the most influential single factor that continuously gives rise to the new complexities, rightly, so observed.

Moreover, this entire approach is based on the assumption that the structure and function of spatial organization is not a matter of how spaces happen to be used in practice, but on how fixed activities are assigned to them and on how trips are travelled and generated between them. This is very consistent with the fact that many of the proponents of this approach took a logician's view of space. They viewed space in isolation from the dynamic circumstances in which it happens to be used. They have accorded 'trip association' a position of great importance in their layout design theories and saw it as a universal category which has been ascribed a universal truth status of fixed meaning and valued wage costs. But, returning to our earlier analysis, we can see that a trip is not a universal category. It is a concept which takes on a specific meaning only in specific social situations. In search of any such meaning, we have to acknowledge the many contradictions (i.e. lack of isomorphisms) which are continuously manifested in the dialectic between a continuously dynamic and changing social process (activities and uses, etc) that gives rise to social space, and the static geometry of physical form that gives rise to physical space. In the terminology developed earlier in this paper, it is easy to imagine

that such contradictions generated by a grid based and trip association design action are, obviously, normal anomalies which do emerge due to the lack of correspondence between the spatial, the activity and the institutional image of a structure.

At a more general level, both Harvey's and Lefebvre's theories on the city and urbanism are concerned with a comprehensive explanation of those contradictions which are generated between a rational organization of society and everyday reality. According to Lefebvre:

"The city, likewise philosophy, historically covered the contradictions between the rational organization of society and the everyday 'reality'. But modern planning practice projected into reality a fragmented rationality that distorted the social practice of the urban dwellers."<sup>15</sup>

This leading contradiction between "rationalization" of society and everyday reality generates a number of secondary contradictions specially concerned with the nature of urban space and its production. Such secondary contradictions are summarized by Lefebvre (1976) in the conclusive chapter of his *La Pensée Marxiste et la Ville*. Firstly, Lefebvre emphasizes the contradiction between the socially produced total space and the private ownership of space which accounts for its compartmentalization. In this way, he argues, space becomes not only naturally compartmentalized in order to become a commodity, but also conceptually decomposed to fit the scopes of different

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15. According to Tchumi (1972, p.581).

disciplines<sup>16</sup>. Secondly, he emphasizes the contradictions between the urbanization of society and, therefore, the absorption of rural areas into the city, and the demand for ruralization of the city, for instance, suburbia, satellite settlements, etc<sup>17</sup>. Thirdly, Lefebvre stresses the contradiction between the increasing control over nature connected with the growing forces of production and the technological advances, and the demand for naturalization of the city by the elimination of the high degree of its artificiality<sup>18</sup>.

The importance of hierarchizing leading contradictions and normal anomalies through a careful consideration of the way in which a system of social evaluation constructs predominancies within a descriptive framework, either in terms of the significance of different descriptive images or the predominancy of one descriptor over the others, can be illustrated in the following example.

Peter Cook (1970) discussing the possibility that architecture will dissolve into being an everyday consumer-durable, a movement which he terms as 'gadgetecture', argues (p.128) that:

"The advent of do-it-yourself is more than just a marketing gimmick: it is *bringing back to the individual at least the "symbols" of involvement*. Perhaps one way through from the design point of view is to look at the problem of do-it-yourself elements as the straight marketing of a building. *Consumer choice then ceases to be a bland catch-phrase and the production of consumer-durables may set up a serious history of development.*" (Our emphases)

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16. *It is interesting to note here the contradictions between the compartmentalization of space and our attempt of conceptual integration in describing space as a totality in terms of the structure of descriptors, the comprehensiveness of the logical tools employed and the structural role of social evaluation.*
  17. *These, obviously, represent normal anomalies at higher levels of planning practice.*
  18. *This type of contradiction has been further exemplified by the discussion on 'comfort' given in pp. 359-62 of this article.*

Looking at the above statement we are supposed to believe in several possible advantages of a 'do-it-yourself gadgetecture' as advocated by Cook. These are mainly: (a) the advantage of containing "symbols" of individual involvement, and (b) the advantage of freeing consumer choice from being a 'bland catch-phrase'.

However, in our view, it is quite easy for anyone to discover that behind this surface level of observable reality the so claimed above advantages immediately disappear and, in fact, are replaced by 'less individual involvement', 'more consumption control over the habitat' and of course 'less consumer choice'<sup>19</sup>. The distinction between leading contradictions and secondary set of contradictions can be used effectively to explain the reasons behind that. However, it might be more productive here to refer to a successfully formulated argument against a consumer-based architecture (gadgetecture) raised by Jencks. Jencks (1973, pp.359-60) argues:

"If it had long been an assumption of capitalism that supply followed demand, then by the sixties it had become equally clear that *demand follows supply*, when this supply is dependent on advanced technology. John Kenneth Galbraith outlined and popularized the qualities which attend any advanced industrial state. First of all, as he pointed out, there is a tendency for wealth and power to accumulate in the hands of a few large corporations: the five hundred largest in the United States produce almost half of all the goods and services of the entire society. Secondly, to ensure their own survival and security, there is a necessity for them to keep pace with a changing technology which is all the time becoming more complex and sophisticated. In order to do this, they must call in expert opinion, which in turn effectively means that the knowledge of any one group or individual is not enough for a decision to be made upon. This decentralizes decisions." (Our emphasis)

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19. See Papaneck's (1974, p.54) criticism of this type of advocacy for a gadgetecture in his book *Design for the Real World*, especially Chapter 4 which is characteristically titled "Do-It-Yourself Murder". This criticism is based on the grounds of social and moral responsibility of the designer.

Jencks carries on to cite the 'Ford Mustang' example given by Galbraith as a paradigmatic proof of his above argument, and then (p.359) he comments:

"With so much at stake in terms of time, money and experts, the Mustang had to work, the public had to be conditioned to accept it, or simply, it had to sell. This it did in fact beyond all expectations."

Further, he continues to stress that the 'Open Society'<sup>20</sup>, in which a free consumer-based architecture is supposed to operate, is in fact a partially closed one.

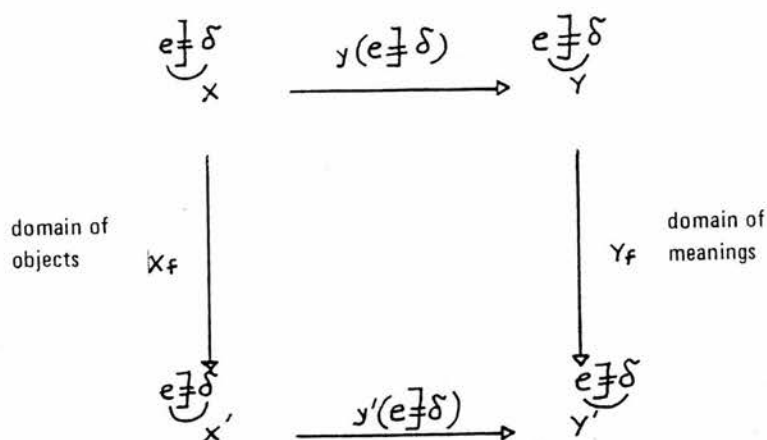
"Thus we have an inversion of both the capitalist ethic and the morality which underlies almost all designers and architects. For the Open Society or consumer pluralism which they purport to serve in fact turns out to be a partially Closed Society which limits the amount and sensitivity of choice. One kind of freedom is being exchanged for another; the freedom to buy an article tailor-made to one's needs is being exchanged for the freedom to select from a limited number of technically sophisticated and conformist products. Or put in the terms of urbanism, the right of interest-communities to determine their specific needs and livelihood is being limited by the affluent majority."  
(Jencks, 1973, p.360).

Finally, we may conclude the discussion in this paper through an example which illustrates how contradictions, either as normal anomalies or as leading contradictions, are involved both in the elementary architectural structures and in their transformational potential into higher order ones.

The notion of the simplest architectural structure has been given by Hiller and Leaman (1974b) in the form of a commutative square:

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20. Jencks refers here to Popper's 'Open Society'.



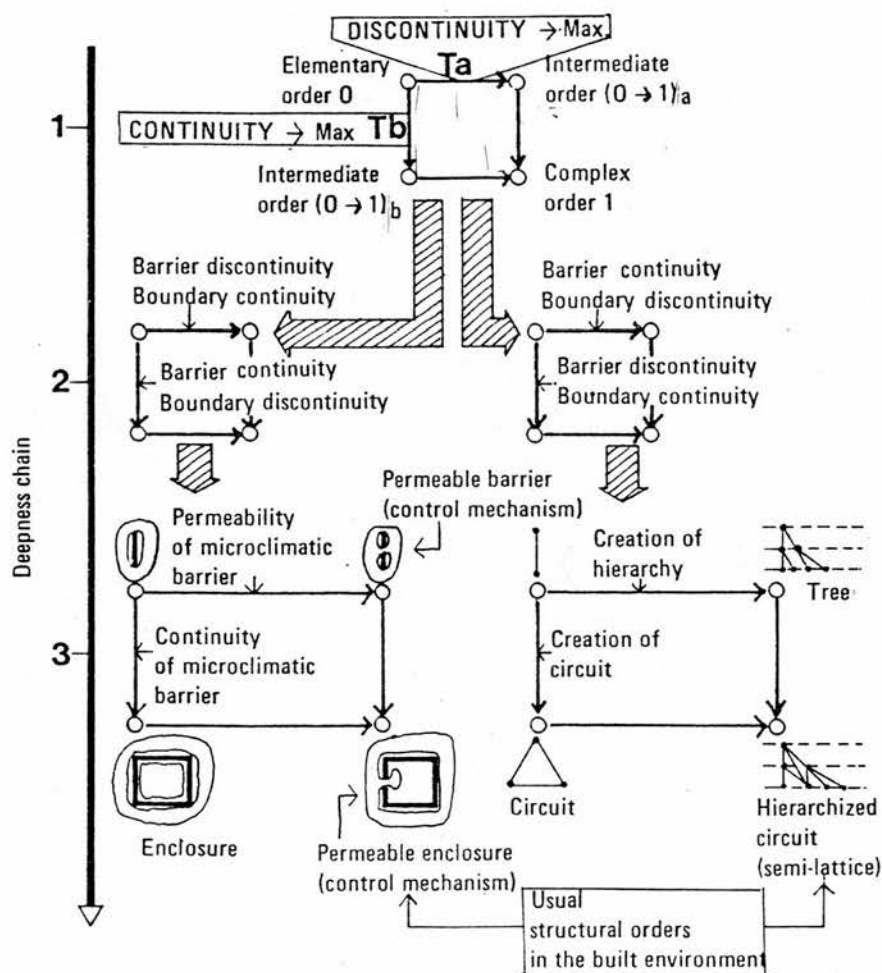
where  $]_{\delta}$  is a wall = is a perforation  $e$  an enclosed space  $\delta$  a defined space and  $\smile$  the structure sign.

#### ARCHITECTURE: SIMPLEST STRUCTURE

However, such a purely Chomskian interpretation of architectural structures, as mapping structures which permit a syntactic explanation of architecture, as the discussion in the E.A.R./3 article has proved<sup>21</sup>, would be in the real danger of explaining intelligible and socially evaluated things in a rather unnecessarily abstract and complicated way, if the syntagmatic identity of architectural

21. See E.A.R./3, pp.44-55.

structures is not seriously taken into account. In our use of the commutative square as representing elementary architectural structures, in the E.A.R./3 argument, the involvement of syntagmatic considerations have been apparently stressed as shown in the following diagram:

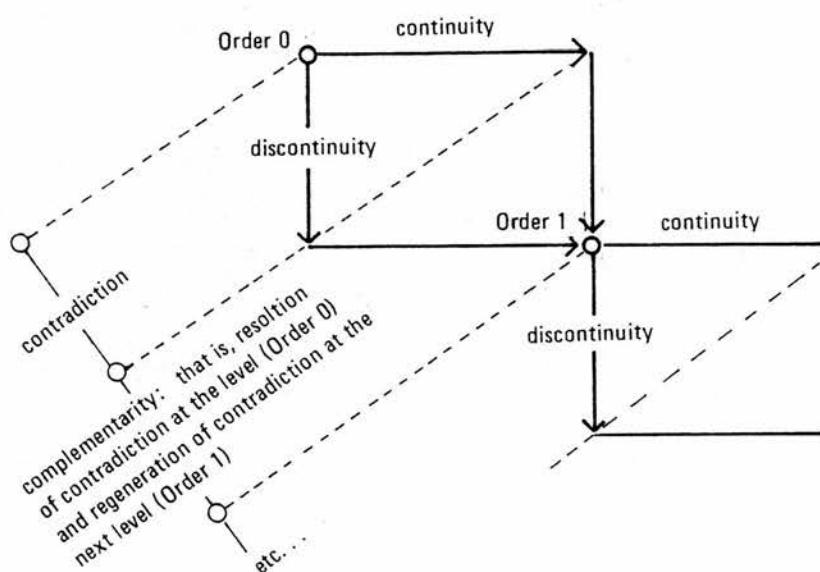


After the E.A.R./3 article, p.54.



'Continuity' and 'discontinuity' first refer to barriers and boundaries and secondly take forms like 'boundary discontinuity through hierarchy' (in order to reach the tree-network, useful for flow regulation) or 'boundary continuity through permeability' (in order to reach the permeable microclimatic barrier, useful for microclimatic regulation).

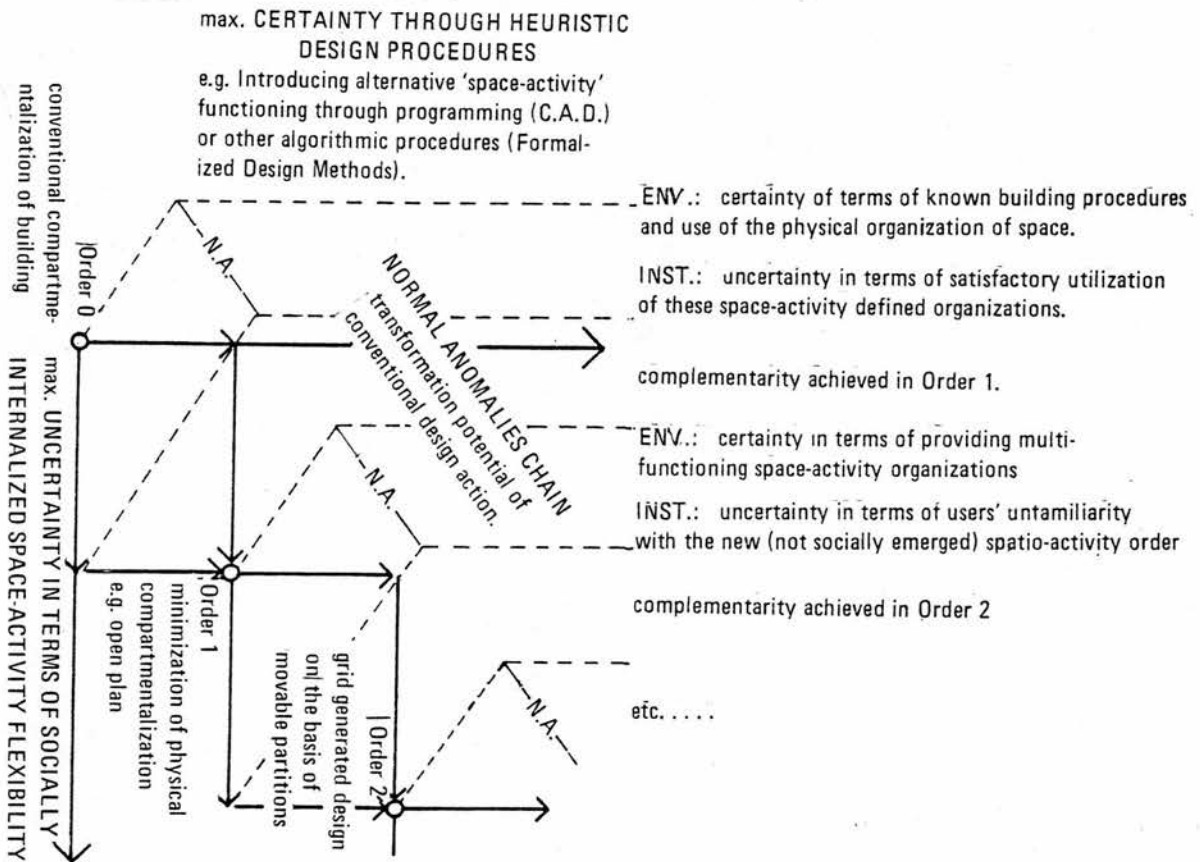
Such contradictory interpretation of even the elementary architectural structures, in fact, attributes to them their syntagmatic nature as well as their transformational potential (see the following diagram):



However, apart from using a 'contradictional logic' to explain the evolution of elementary architectural structures, such as

microclimate and networks, it is also possible to consider this logic applicable to certain architectural movements, for instance, 'functionalism', in order to explain how multi-dimensional (e.g. spatial-activity) structures acquire their transformational potential. Thus, it may become apparent that both normal anomalies and leading contradictions are accountable for the transformation of the structure as a whole, but, also, that at the level of design action contradictions are generally formed as normal anomalies, while leading contradictions - though present all the time - specifically contribute to the transformational potential of a structure only within a much broader socio-economic and political framework.

A way to examine the transformational potential of a spatial-activity structure at the level of design action is to consider comprehensive architectural descriptors, such as design flexibility, within a commutative square logic defined by the bipolar 'certainty' (in terms of the space activity multivariable function) and 'uncertainty' (in terms of the social internalization of this function):

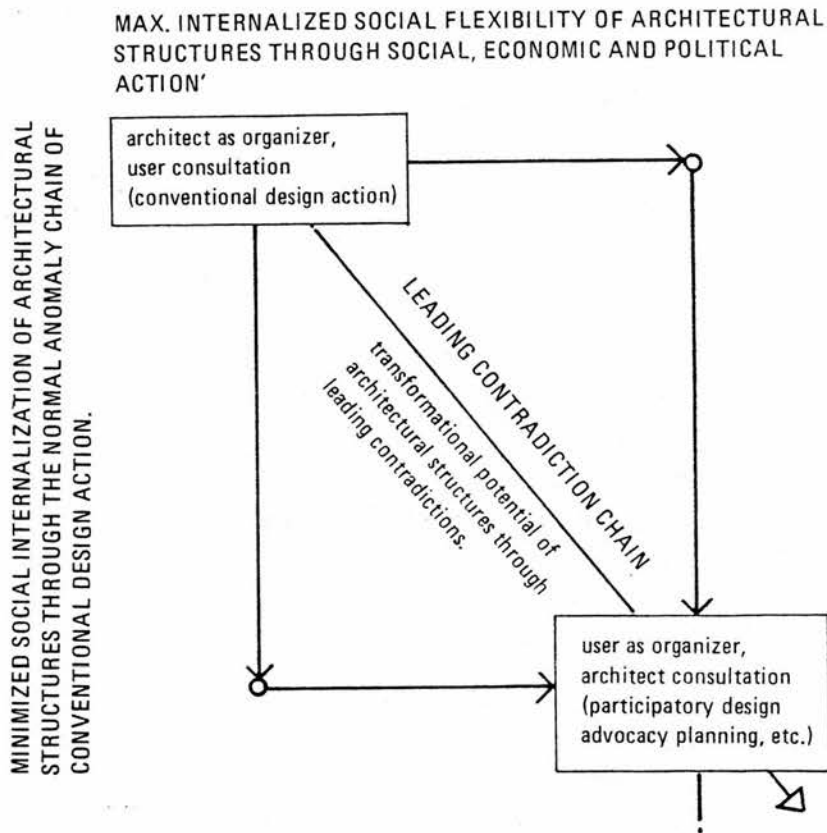


\*See Note 22

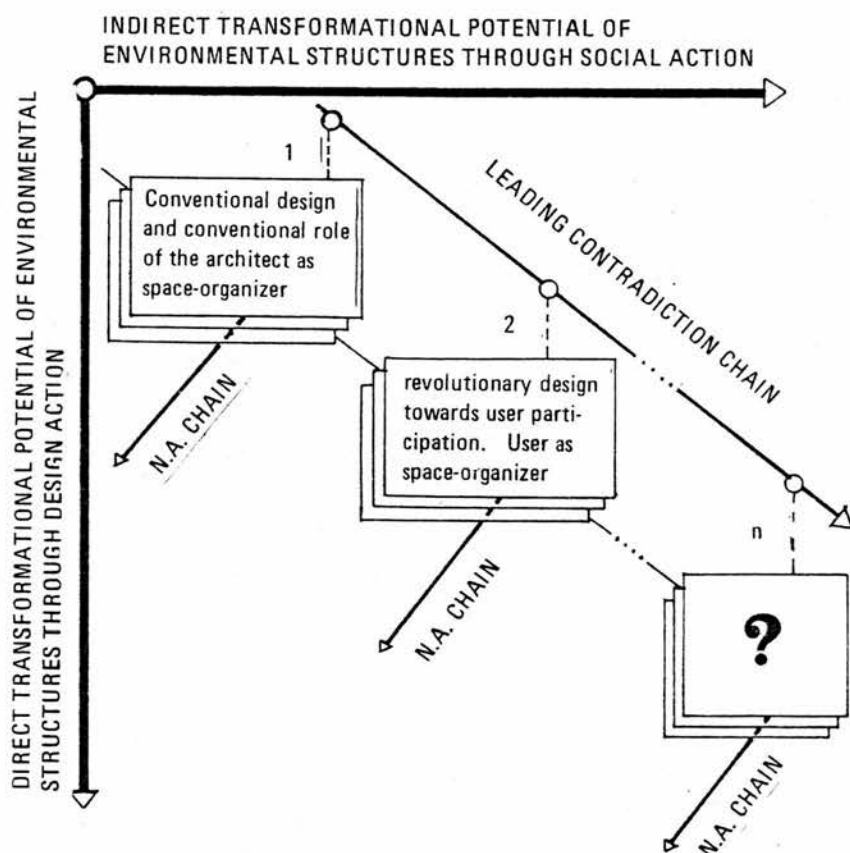
22. The examples given in the diagram above represent one way of explaining through a contradictional logic the transformation of space activity organization in buildings as it is observed in modern architectural practice. Furthermore, it is interesting to notice that the chain defined by these examples (order  $0 \rightarrow 1 \rightarrow 2 \dots$ ) also represents a chronological order reflected in the modern history of architectural movements.

The contradictions which appear during design action, that is, between certainty - in terms of providing, through heuristic procedures, a repertoire of alternatives at an environmental level for space-activity functioning - and uncertainty - in terms of the social internalization of these alternatives at an institutional or an activity level - are obviously normal anomalies well recognizable within the context of conventional design. The above diagram explains how a structure acquires its transformational potential through a repetitive process of resolution and regeneration of such normal anomalies. It also shows the structural role of social evaluation in terms of identifying normal anomalies which account for the transformational potential of a structure.

However, it is possible to identify transformations of architectural structures by means of leading contradictions occurring, for instance, only within the institutional image of these structures. Consider once again the above diagram. It is obvious that at higher levels where the structure acquires its maximum flexibility in environmental terms, the institutional image of it presents a very low social internalization of this flexibility. In this context leading contradictions of the following type are easily recognizable in these structures:



The hybridization of the two diagrams above presents the total transformational potential of an architectural structure. This explains the importance of considering both normal anomalies and leading contradictions in describing integratedly the dynamics of these structures.



A CONTRADICTIONAL INTERPRETATION OF THE DYNAMICS OF ENVIRONMENTAL STRUCTURES.

To conclude, in this paper we stressed the descriptive implications that the multi-disciplinary character of architectural structures brings to their investigation. In doing so, we extended the limited view of the concept of environmental structure we took in E.A.R./3 by further ascribing to it a descriptive dimension, which

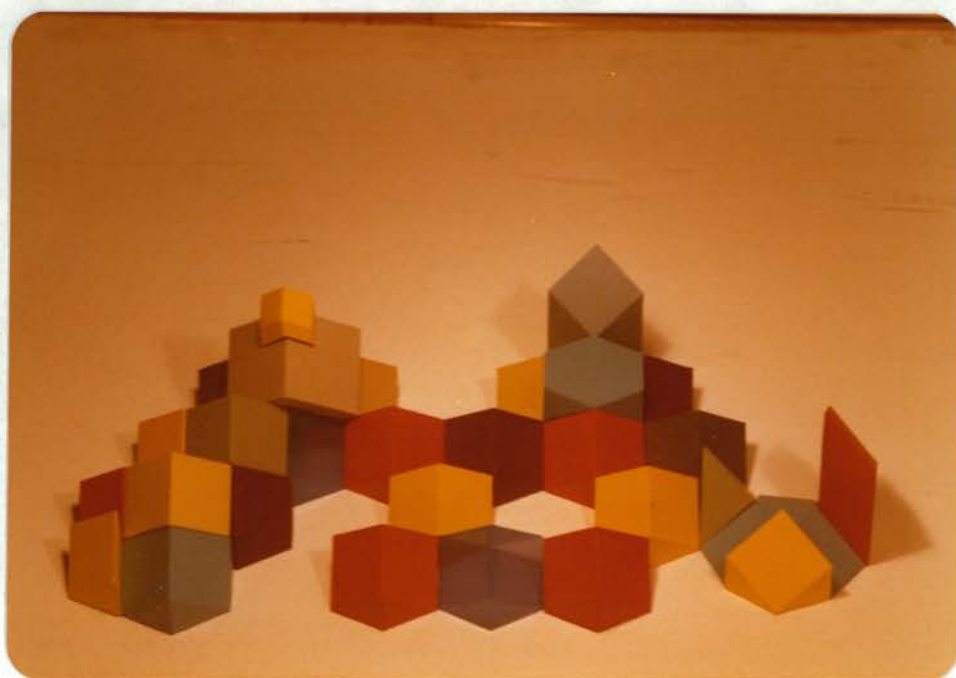
we found to be necessary if the formulation of any comprehensive descriptive theory is to be achieved. In addition we presented the view that a 'contradictional logic' necessitated by the involvement of the descriptive dimension and incorporated within the methodological framework of 'syntagmatic approach' becomes a useful dialect for studying the identity, dynamics and transformations of architectural structures and contributes to the descriptive theories concerned with them.

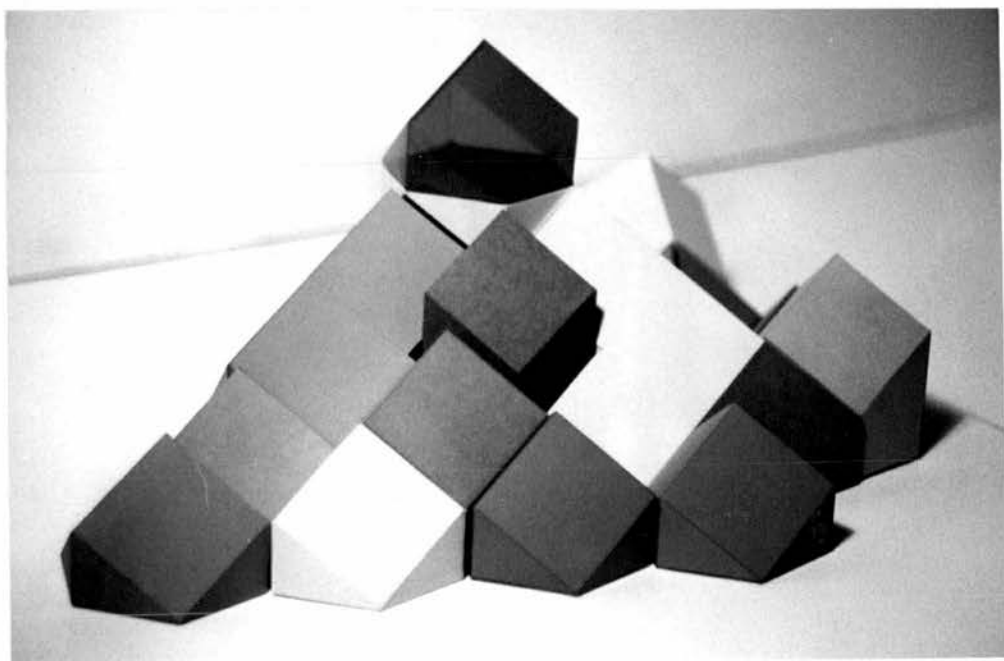
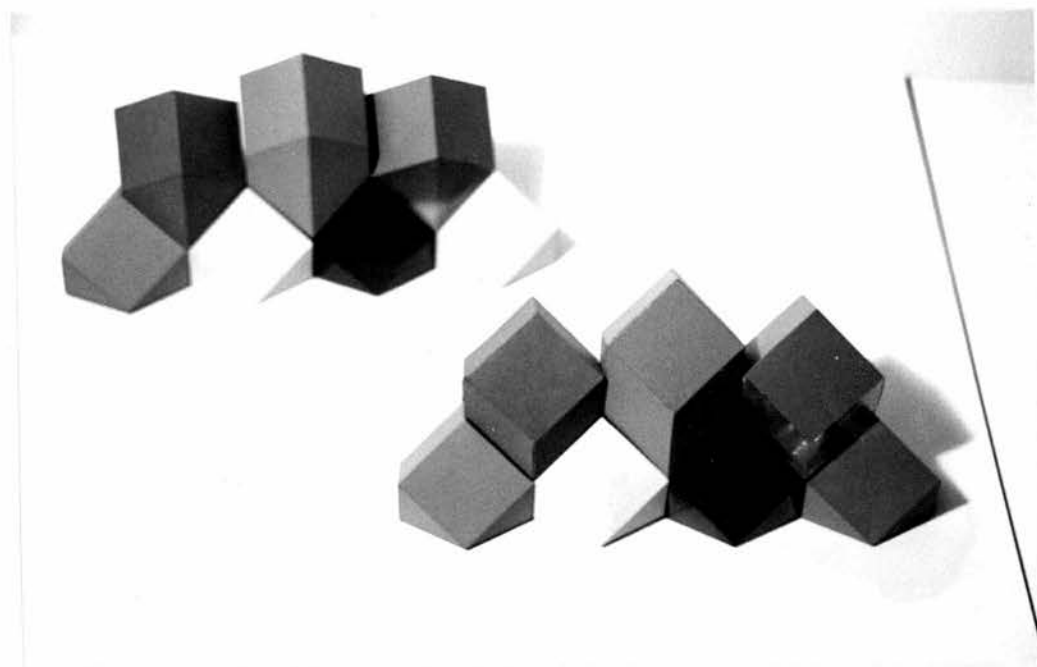
In both this article and the E.A.R./3 one, we advanced some theoretical arguments concerned with the problem of comprehensive description in architecture, developed within the methodological framework of structuralism, giving particular emphasis to the terminology concerned. It seems to us, however, that the discussion could have been further elaborated and developed, at certain points, to support our arguments but at this junction, we felt it would be more productive to concentrate on a detailed experimental examination and evaluation of our major assumptions. To a certain extent, this is being carried out at the level of our individual research. Nevertheless, we hope that this task will constitute a further area in which our future collective research will continue.

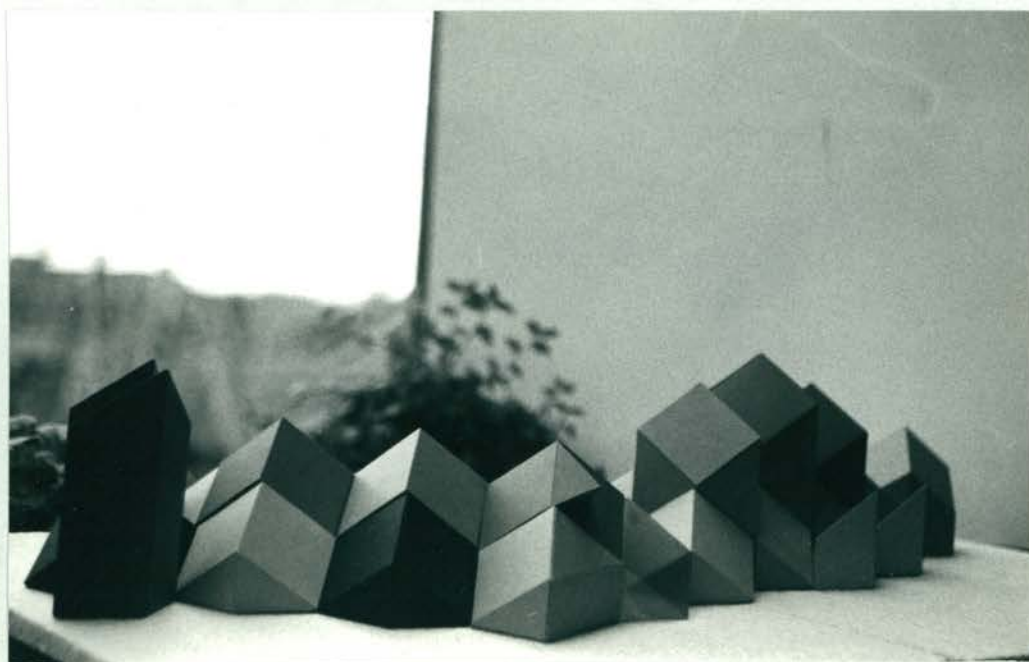


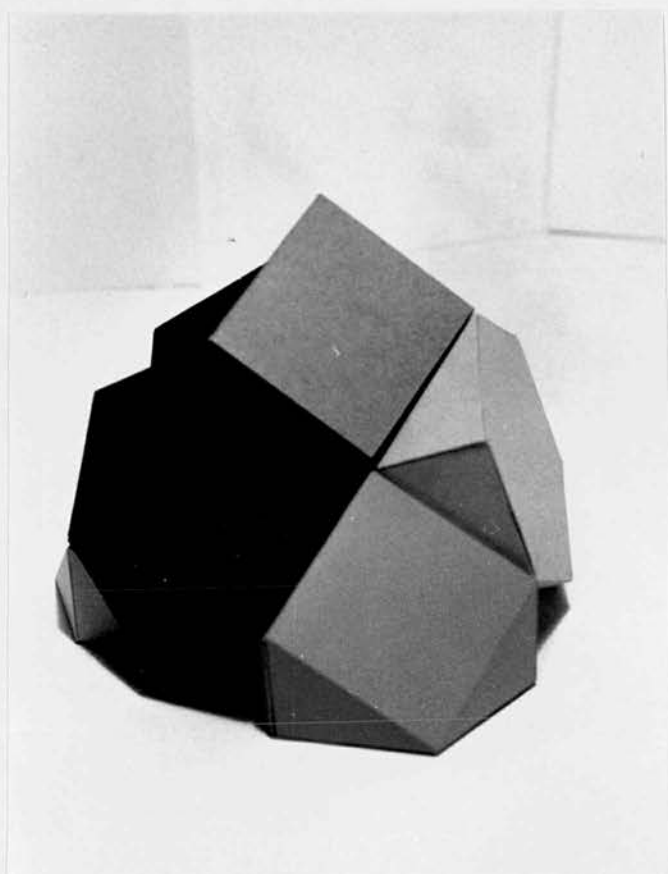
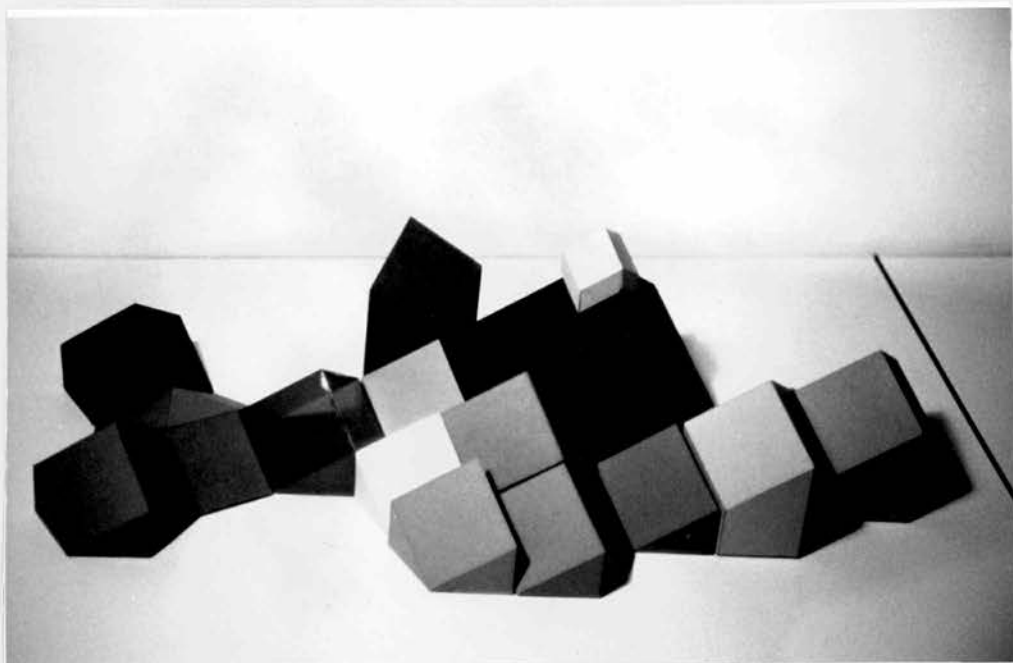
## APPENDIX III

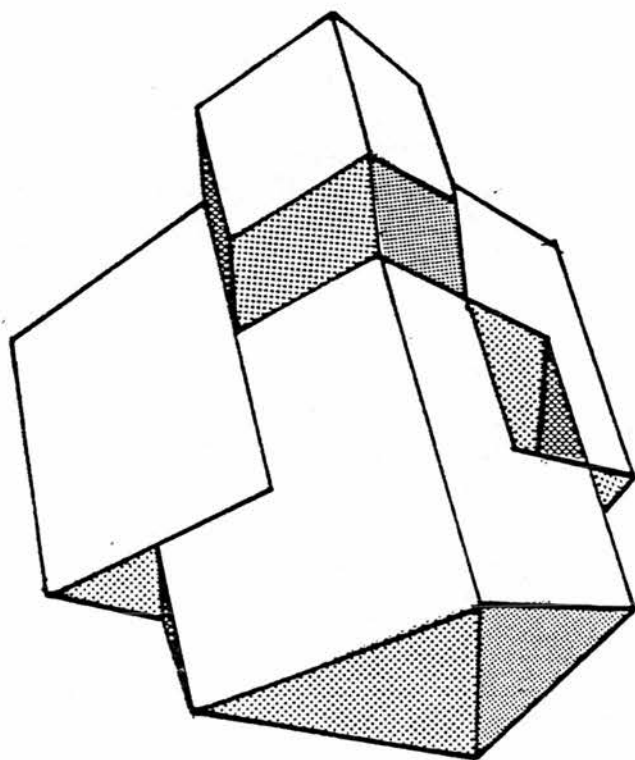
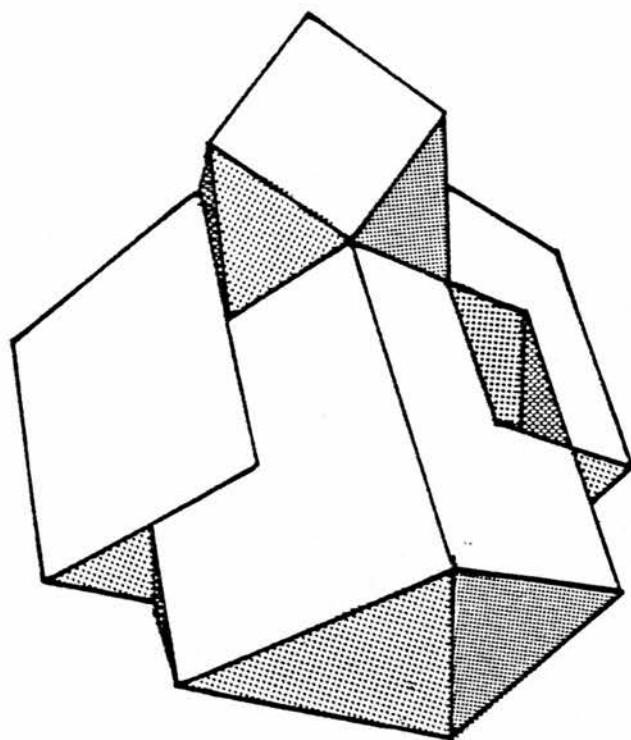
## GRAPHICAL SUPPLEMENT TO CHAPTER 10

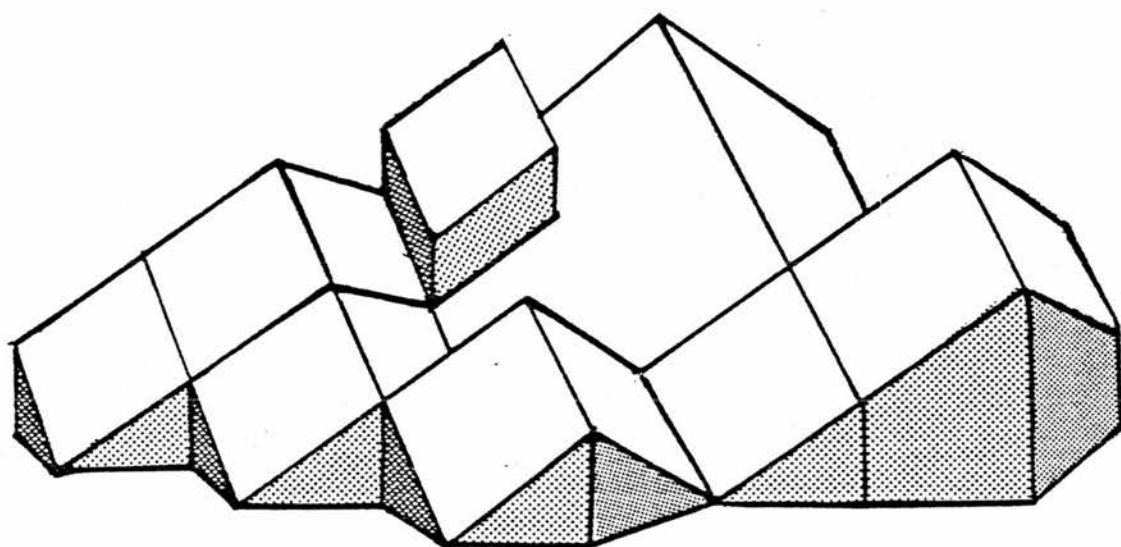
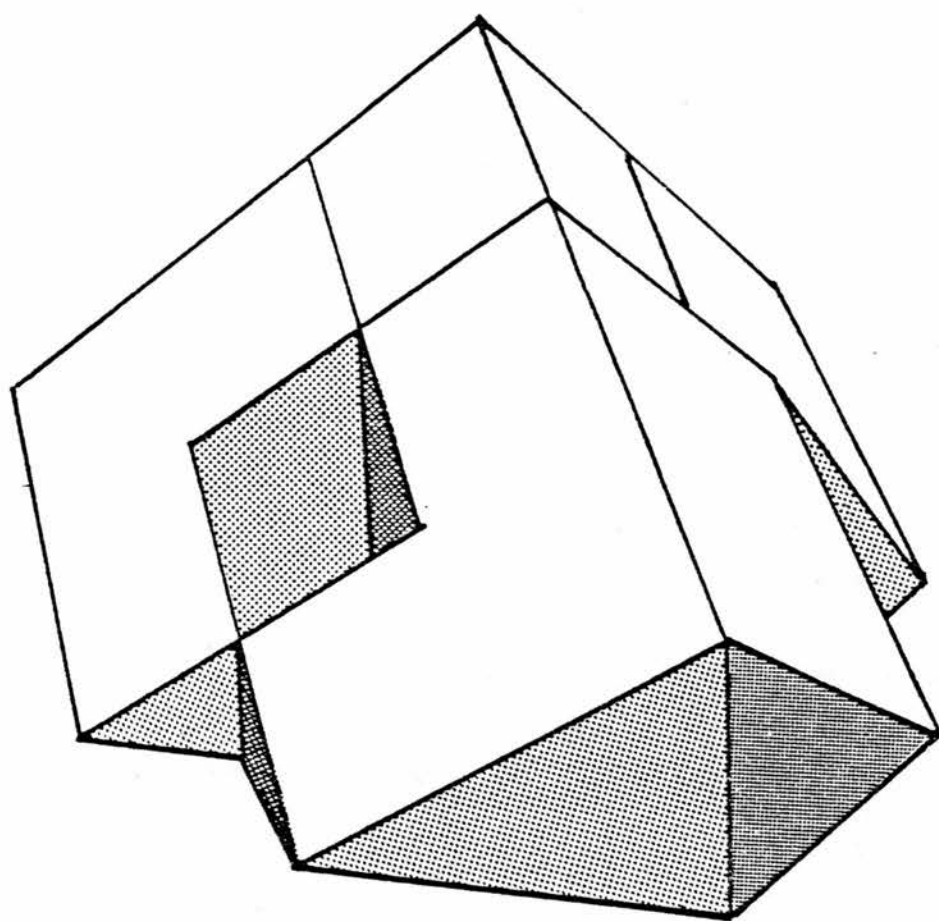




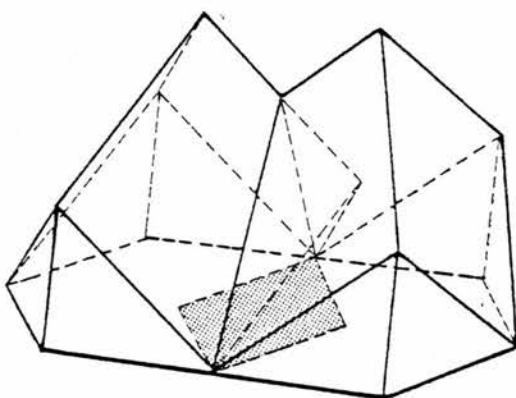
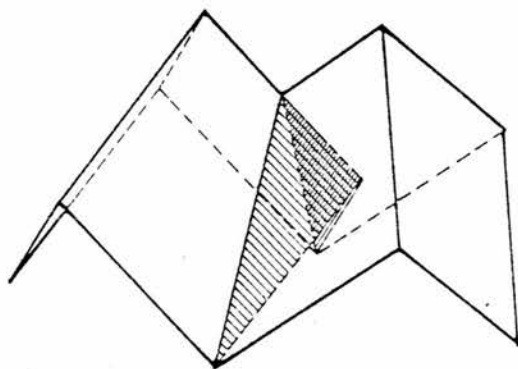
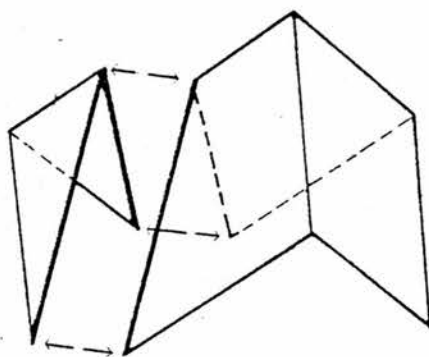
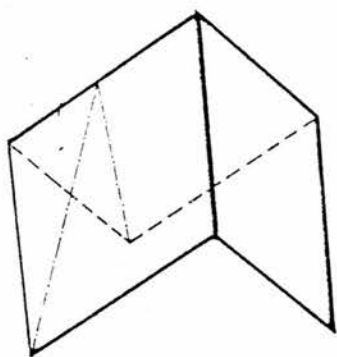
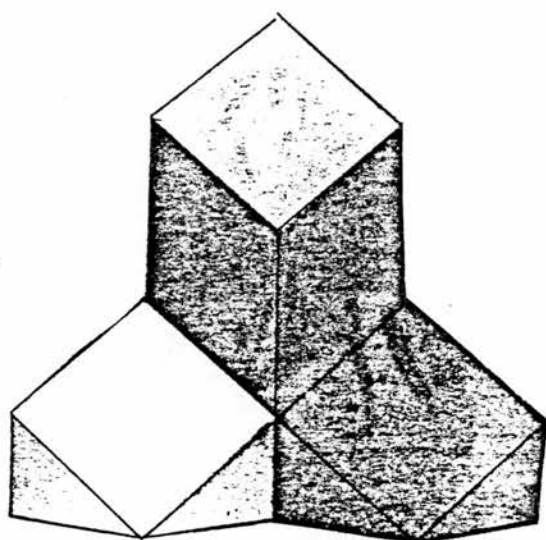
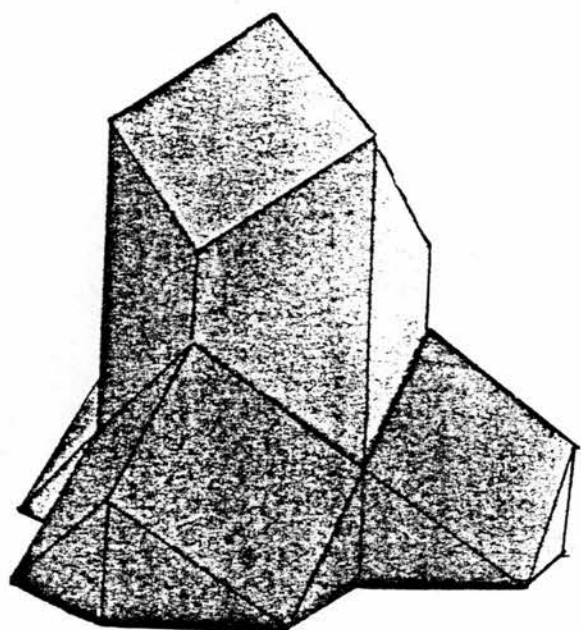




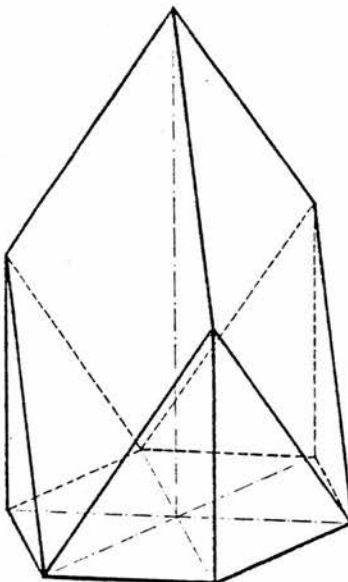
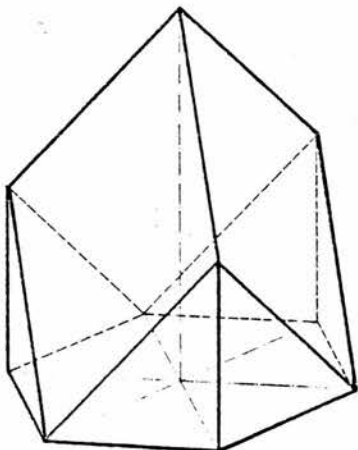
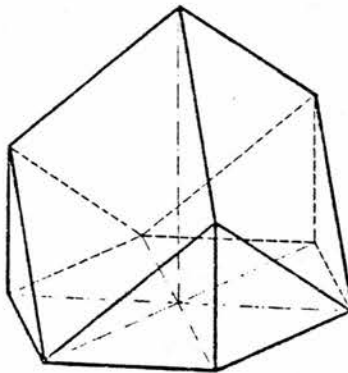
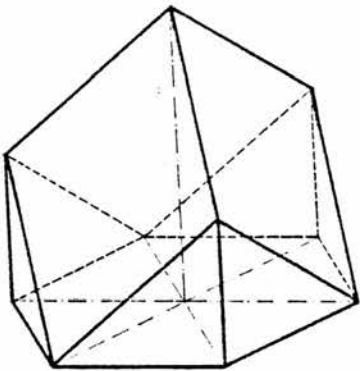
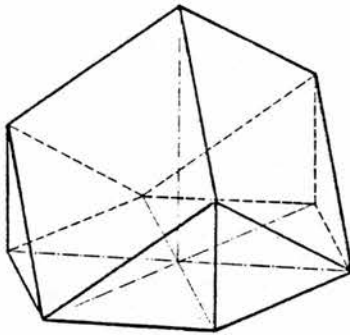
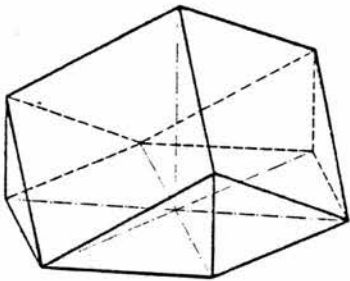
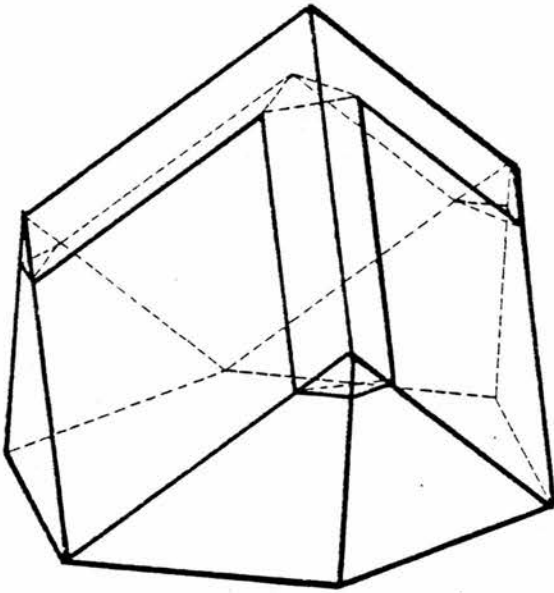


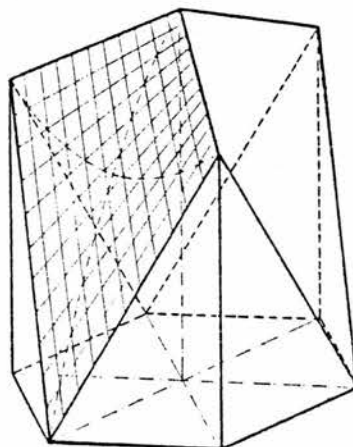
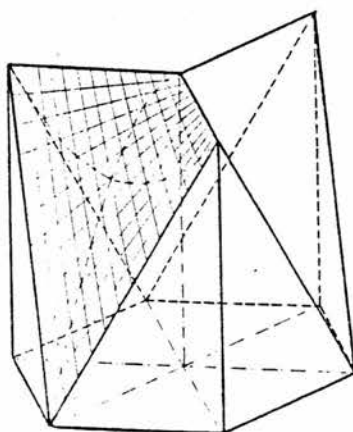
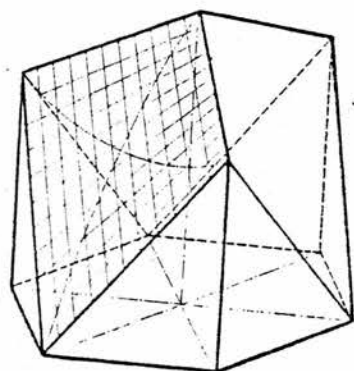
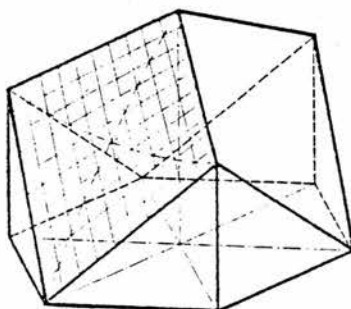
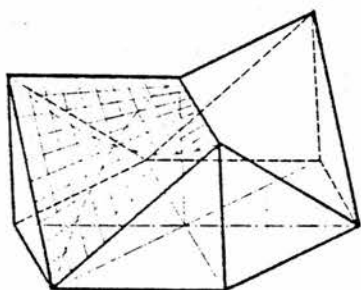
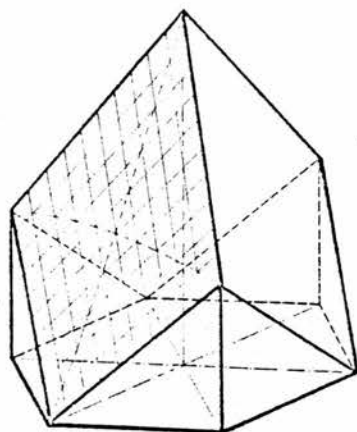
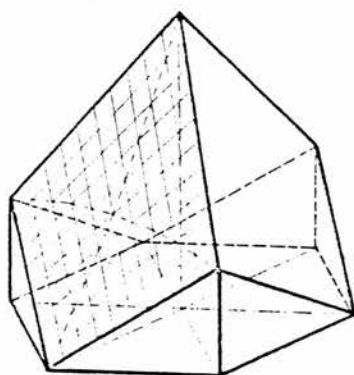












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| AD           | Architectural Design                                 |
| AJ           | The Architects' Journal                              |
| ART          | Architectural Research and Teaching                  |
| EAR          | Edinburgh Architecture Research                      |
| JAIP         | Journal of the American Institute of Planners        |
| RIBA Journal | Journal of the Royal Institute of British Architects |

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